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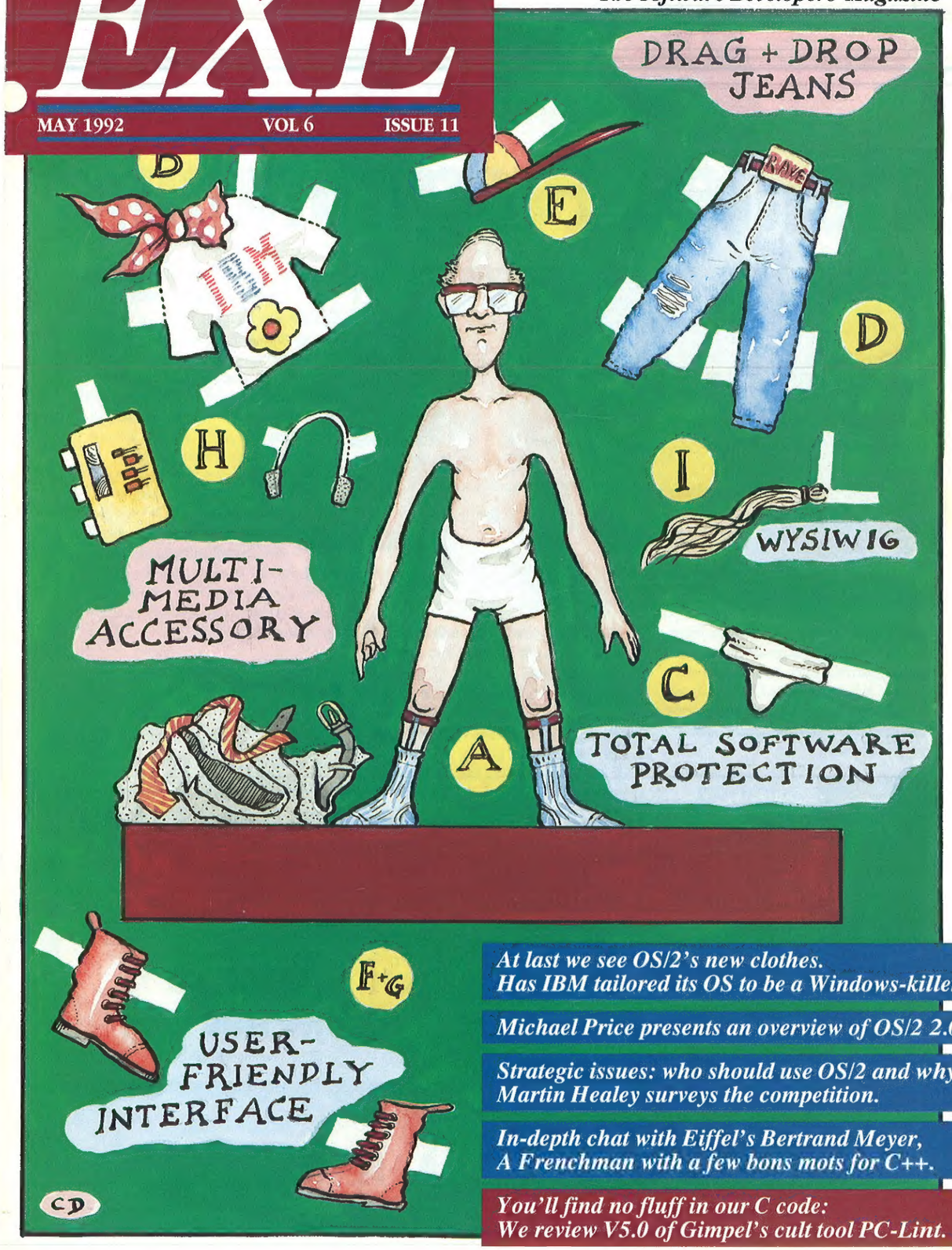
EXE

The Software Developers' Magazine

MAY 1992 VOL 6 ISSUE 11



At last we see OS/2's new clothes. Has IBM tailored its OS to be a Windows-killer?

Michael Price presents an overview of OS/2 2.0.

Strategic issues: who should use OS/2 and why? Martin Healey surveys the competition.

In-depth chat with Eiffel's Bertrand Meyer, A Frenchman with a few bons mots for C++.

You'll find no fluff in our C code: We review V5.0 of Gimpel's cult tool PC-Lint.

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B O R L A N D

Vol 6 Issue 11

.EXE

May 1992

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Tel: (Advertising/Editorial/Production) 081 994 6477
(Subscriptions) 0442 824501
Facsimile: 081 994 1533 Telex: 8811418 SPACES G
ISSN: 0268-6872

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.EXE Magazine is a monthly journal for software developers. It is available only by subscription, at a cost of £35 per annum (11 issues) in the UK, £50 for 2 years. Overseas subscriptions cost £45 per annum, £70 for 2 years. 'A subscription implies that this journal will be sent to the subscriber until one of the three expires' - AG Macdonell. The magazine is published around the 26th of the month preceding the cover date. There is no January issue. To subscribe or obtain details of overseas/academic rates, please call 044282 4501, or write to The Subscriptions Manager, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. We can invoice your company or take ACCESS and VISA cards. In case of a query about your subscription, please call 044282 4501.
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Editorial enquiries should be addressed to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. We welcome letters, opinions, suggestions and articles from our readers. Please write for a copy of our Contributors' Guide.
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Pronunciation

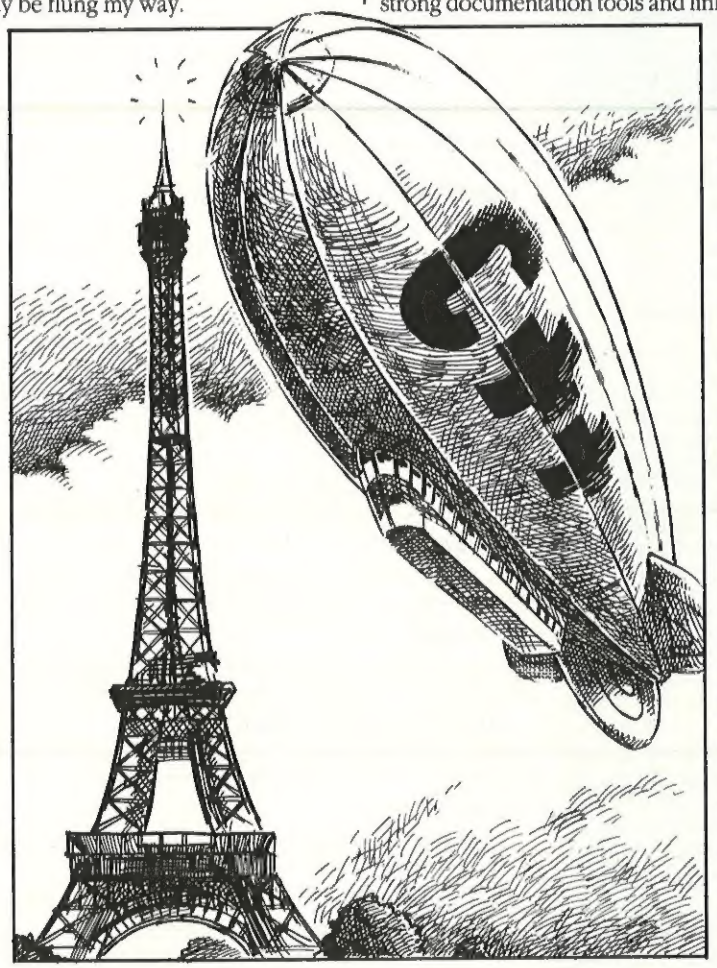
.EXE Magazine rhymes with 'not sexy magazine'.

Issue theme: OS/2

Oh no, not again...

At the beginning of the 1980s, Pascal and C slugged it out for the title Best General Purpose Programming Language. Will Watts believes the battle is about to be re-fought.

Of course, you might view it as a piece of pure cynicism on the part of .EXE Magazine. There can be no doubt that quarrels over methodology, especially language quarrels, are the very meat of readable editorial. (Quiche eater! Assembler programmer!) However, there is a battle hotting up, virtually a rematch, which is now beginning to spill out of the towers of academia into real life, and I believe that its importance to software development is sufficient to quash any accusations of warmongering that may be flung my way.



In the blue corner, then, we have Bjarne Stroustrup's C++. This is the conservative choice, and must be the general current favourite to win. With all the major compiler vendors either offering or promising C++, its impact on the market is assured. There are plenty of C programmers waiting to be post-incremented (I know it's not that simple, but that is the deepest level of understanding you'll get out of the average recruitment consultant, which may be what matters) and the machinery of standardisation has long since been set in motion.

Opposition to C++, it seems to me, comes in the form of two main school of thought (not necessarily mutually exclusive). There is the camp which never cared for C anyway - the 'quiche eaters'. These people never acknowledged that the flexibility of C justified the dangers that its use introduced. To them, C++ is even more of a monster; a few of the more gross type problems cleaned up, perhaps, but the potential to create cataclysmic cock-ups from gargantuan, incomprehensible multiply-inherited hierarchies with a confusion of pointers and references exploding in all directions.

The other class (sorry) of anti-C++ talk comes from the object-oriented purists. Briefly, this camp hates C++ for its mixture of procedural and OOP programming. Their slogan could be: 'Do it properly or let it alone!'

Where should these malcontents hang their standard? OOP pioneers LISP and Smalltalk have established their niches, but the consensus is that they are going to stay in them. They are just too wacky for their own good.

Alternatively: every manufacturer of 3GL or 4GL languages is currently nailing on OOP extensions; we can expect COBOL and Basic any moment now, and I dare say in some distant garret even dear old FORTRAN is getting the treatment. But languages created in this way must suffer from the same lack of 'purity' as C++ itself, and, what's more, are unlikely to have benefited from the same careful engineering as Stroustrup's team has put in. No help from the old Pascal/Modula master Niklaus Wirth; he has unusual views regarding what OOP is about *(see .EXE May 1990)* and is isolated from the mainstream.

So we come to Eiffel. Meyer's language is a 'clean' OOPL, like Smalltalk, and has an associated programming environment. Unlike Smalltalk, it compiles and links like a 'proper' language. On the page, it reads like a Pascal variant - it doesn't require you to abandon all the programming conventions you have ever learned. It has a library, and strong documentation tools and linkage to existing C code. It is strictly typed in the Wirthian manner, but avoids many of those tiresome re-declarations that you find in Ada and Modula-2. It has a fistful of extensions to the basic OOP ideas. In short, it's pretty *neat.*

What is the C++ camp's view of Eiffel? About a year ago, I mentioned to Stroustrup *(Reader's voice: 'Ooh, you disgusting name-dropper!')* that I admired Meyer's first Eiffel book, and wondered if this wasn't the way to go. Stroustrup shook his head and said mildly: 'Go away, try solving a real problem in Eiffel, and see what you think.' Which I interpret to mean that Eiffel contains impracticalities that you only hit when you get into real-life problems.

This, of course, is very close to the old argument offered by C proponents against Pascal. Pascal was great - provided you didn't need to pass variable length strings to a procedure, or use files, or create multi-module programs, or get at low-level machine features. All Pascal's major problems (except not being the basis of UNIX) were eventually solved by proprietary implementations and by the Modulas - but by then it was too late.

The practical problems of C++ are now emerging rapidly from the woodwork under the sheer pressure of the huge numbers using it. They are not blaring faults, as were found in the intended-for-teaching-only language Pascal, but they are there, and they are often solved by the design of Eiffel. But then Eiffel is mostly untested, so...

In the end, the ideal thing to do is to take Stroustrup's advice, and find out for yourself. (I have not, I must admit guiltily, yet been able to do this - the only Eiffel implementation ever seen in this office is currently out for review. But I will.) Most likely that is a tall order for most of our readers, in which case this piece serves simply to alert you to the fact that there is still life outside the *Sturm und Drang* of C++.

EXE

To find out more about current implementations of Eiffel, you should contact Applied Logic Distribution (081 780 2324).

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TPW V1.5

Borland has announced an intermediate upgrade for Turbo Pascal for Windows. TPW V1.5 will include support for Windows 3.1 (TrueType, OLE, Drag and Drop etc), the latest version of Resource Workshop (replacing the Whitewater Toolkit), Turbo Debugger for Windows, colour syntax highlighting and a SpeedBar. However, there will be no class browser as seen in Turbo C++ for Windows. US upgrade price is $50 and the package should appear within the next few weeks.

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3.1 - It's Here

It has been a busy month for Microsoft. First, the long awaited successor to Windows 3.0 has finally arrived. That's right, Windows 3.1 is here. Offering a range of improvements over its predecessor, 3.1 is almost guaranteed to be a huge success. Among its notable features are True Type fonts (scalable type-faces for WYSIWYG output), Object Linking and Embedding (OLE), multimedia and better network support. With several major PC manufacturers, including AST and Dell, committed to providing Windows 3.1 pre-installed, it would seem that Bill Gates has again backed a winner.

Then there's Professional Toolkit, a new addition to the Visual Basic product line which provides a number of new programming tools and controls for creating VB applications. There's a new Grid control which lets you create spreadsheet-like displays. Microsoft has also provided controls for MDI and OLE. The Bits Per Second ChartBuilder Control has been thoughtfully included with the toolkit (see *.EXE* Oct 1991 - *Windows Graphics Without Tears*). This enables VB applications to display graphs including 3D pie and bar charts. Other controls include 3D versions of the standard Check Box and Push Button, animated buttons which are capable of displaying several different bitmaps in sequence, and a rather nifty Gauge control which bears a remarkable resemblance to Borland's 'speedometer'.

Other features of the Professional Toolkit include support for multimedia, Pen computing and the Visual Basic Setup Kit which provides a set of tools for writing your own setup programs.

Windows 3.1 costs £99, although the upgrade price for existing Windows users is £45. The Professional Toolkit for Visual Basic is priced at £199, but until the end of May 1992, Microsoft is offering the toolkit to registered users of Visual Basic at a cost of £79. Phone Microsoft on 0734 270001 for details.

IBM ships OS/2 2.0

Just in time to meet its oft-quoted release date, IBM has announced the availability of its 32-bit PC operating system. OS/2 2.0 delivers three operating environments in one - DOS, Windows (applications run in standard mode) and OS/2. It will ship with over 25 'Applets' and includes the Adobe Type Manager for both Windows and PM. Borland is expected to make a PM-hosted C++ compiler available within the next few months and Watcom C V9.0 already supports the operating system. In response to criticism of hardware dependency in OS/2 1.x, IBM has established an OEM test lab in Florida. So far about 100 OEM models have passed compatibility tests.

Until 30 June the following promotional prices will apply: £40 to upgrade from OS/2 1.x, £50 for current Windows users, £65 for current DOS users and £90 if you don't have an operating system at all. The deal includes free 60-day helpline telephone support. For details ring 081 7470747.

For OS/2 developers there is an OS/2 2.0 Tools Conference to be held at the IBM South Bank Centre in London on 18-20 May 1992. The cost per delegate is £595 + VAT for the three days. Ring Natasha Warner on 0256 56144 for further information.

Borland's Brief

Borland has acquired two new programmers' tools from the US company Solution Systems: the popular (but pricey) Brief programmer's editor and the Sourcerer's Apprentice version control system. Both products will be re-packaged by Borland and integrated into its product line. Brief will continue to be sold as a standalone product, and special hooks will be built into the language IDEs to make using them with Brief easier. Also, some Brief capabilities will be included with the standard IDEs. According to Borland CEO Phillipe Kahn, a Windows version of the editor can be expected 'real soon'. Sourcerer's Apprentice, renamed as 'The Borland Source Control System', will be integrated into Borland's Language IDEs.

Borland hired Solution Systems' programmers when it bought the products, so it hopes to continue with development apace.

Windows Ada

Ada is now available for Windows thanks to R.R. Software. The Janus/Ada Windows toolkit works in conjunction with the Janus/Ada Professional Development System for MS-DOS. It includes an Ada interface to the Windows 3.0 and 3.1 API. It also comes with two additional Windows interfaces. The first is Ada-like which provides the Ada programmer with a simpler interface. The other Windows interface is a binding which is capable of converting existing text-only applications to Windows without re-compilation. The Janus/Ada Windows Toolkit is priced at $400. The Janus/Ada Professional Development system for 386 MS-DOS contains a validated Ada compiler and costs $500. For further information contact R.R. Software on 0101 608 2513133.

Borland C++ training ...

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"Yes Jim."

"This strange fragment, what is it?"

"It's code, Jim. C code, but not as we know it."

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Windows tester

Microsoft Test for Windows is a graphical testing tool designed to create and run automated test scripts for Windows-based applications. It is targeted at software developers but can also be used by purchasers for acceptance testing. The recorder generates scripts in a flavour of Basic by trapping mouse and keyboard events. The Test DLL can also be called from any programming language that supports DLL access such as C, Pascal or Visual Basic. Test suites can be run unattended with the results being logged to a file for subsequent examination. Test for Windows costs £279. For further details, ring Microsoft on 0734 270000.

Rocky C

Developers using HP BASIC or Rocky Mountain Basic can now port their applications to almost any platform that supports the C programming language, thanks to HP BASIC to C Translator from Workstation Source. The Translator costs £2,500. Workstation Source is on 0442 876234.

Foxy Graphics

Bits Per Second has introduced a new version of its dGE graphics library for xBASE. dGE for FoxPro V2.0 is distributed as a PLB (Fox's version of a DLL) and Bits Per Second has indicated that the new release offers double the performance of previous versions and eliminates the overhead associated with 'memory-hungry TSR drivers'. dGE for FoxPro V2.0 cost £245. Phone Bits Per Second on 0273 727119 for details.

9K in UK

So called to associate it with international quality standard ISO9000 (equivalent to BS5750 over here), 9K is a new version control system from Forté Software. Of particluar interest to xBASE developers is the fact that 9K recognises dBASE files and can monitor changes in structure and data. The product is distributed in the UK by QBS Software (tel: 081 9944842) and is priced at £149 for a single-user DOS version. A multi-user LAN version will be available shortly priced at under £500.

Who said that?

Quantech, the company that gave your PC a human voice (see .EXE Dec 91 - Sounds Peculiar), has done it again. The latest version of SoftSpeak II+ is compatible with the SoundBlaster/ThunderBoard sound cards and can also use the WAV sound files of Windows 3.1. The software-only version of SoftSpeak is priced at £59.90 with the development version at £189.90. Speak to Quantech on 091 2280513 for more information.

Fox falls to Microsoft

Microsoft's acquisition of Ohio-based Fox Software signals the company's late entry into the dBASE language arena, and is seen by many as an attempt to prevent Borland from dominating the market. Borland share prices fell with news of the announcement. Commenting on the deal, George Fletcher MD Nantucket UK said 'it reveals that Microsoft is not as advanced as it had led people to believe with its own database product, Cirrus'. He went on to soothe Clipper users by saying that 'from Nantucket's point of view, there is no threat to our leadership in the application development tools business, since neither Fox nor Microsoft has a compiler at present for either FoxPro or Cirrus'.

As part of the 'merger', David Fulton president of Fox, will join Microsoft as the database architect of Microsoft's newly formed Database and Development Tools division.

The deal leaves Nantucket battling with the two software giants for a slice of the lucrative xBASE market which has been in such turmoil in recent months.

Embed with Borland C++

C++toPROM from Systems & Software allows Borland C++ to be used to generate ROMable applications. The product takes an .EXE file and converts it to .BIN format for loading into PROM emulators or programmers. The user has complete control over the placement of code in the target system as well as being able to use memory mapped I/O at absolute addresses.

Another option is the production of .OMF files required by ICE or by target monitors such as SoftProbe TX. The C++toPROM package includes all the code required to initialise the system hardware and segment registers.

C++toPROM is priced at £255 and is distributed in the UK by Computer Solutions (tel: 0932 352744) which also provides similar products that work with Microsoft, Watcom and MetaWare C compilers.

dBASE Custom Ctrl

Q+E Database/VB (QEVB) is a new custom control for Visual Basic which provides the programmer with a tool for building Windows database applications with VB. The Query control enables the programmer to set up such information as the database to access, the sort order and the query to perform in a similar manner to how you would alter the properties of a VB ListBox. Once the Query Control has been 'drawn' onto a VB form, it can be used to provide automatic access to a database whenever a given VB control is clicked.

QEVB also provides a Grid control which enables you to display all the records and fields in a database. This provides a neat way of adding a database browser to your applications. QEVB is compatible with dBASE and supports both dBASE III and IV indexing. It also supports file-locking for writing multi-user applications. QEVB is distributed in the UK by Contemporary Software who is offering it at £99 for a limited period. Contemporary Software is on 0273 483979.

Too .EXE For My Shirt

Here's a photograph of our Kate Adams (left) with her captain posing in a rather trendy rugby shirt. Notice that awesome designer label, an icon of good taste and impeccable style? That's right, .EXE is sponsoring the first East to West Coast rugby tour undertaken by a women's rugby team. 23 members of the Richmond Women's Rugby Club will be travelling from Boston to San Francisco, playing five games in all. Good luck Kate!

How Portable?

Open System Portability Checker from Knowledge Systems is a tool which allows you to determine the extent to which your UNIX applications conform to a number of standards including the X/Open Portability Guide (XPG), POSIX.1, POSIX.4, POSIX.16 and the ANSI C Standard.

Source code can be tested to ensure that it adheres strictly to a given standard. The type of objects can be checked over several modules and it is possible to determine whether function calls are given the correct number of parameters with the correct parameter-types. At run-time, Portability Checker monitors all system calls and checks the correct usage of pointers in order to track down 'out of bounds' errors. Open Systems Portability Checker is available on Sun 4 and is priced at £6,000 for a single-user licence. Knowledge Systems is on 0252 520667.

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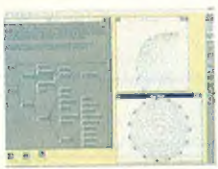

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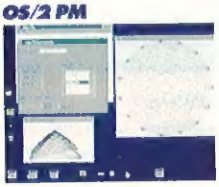

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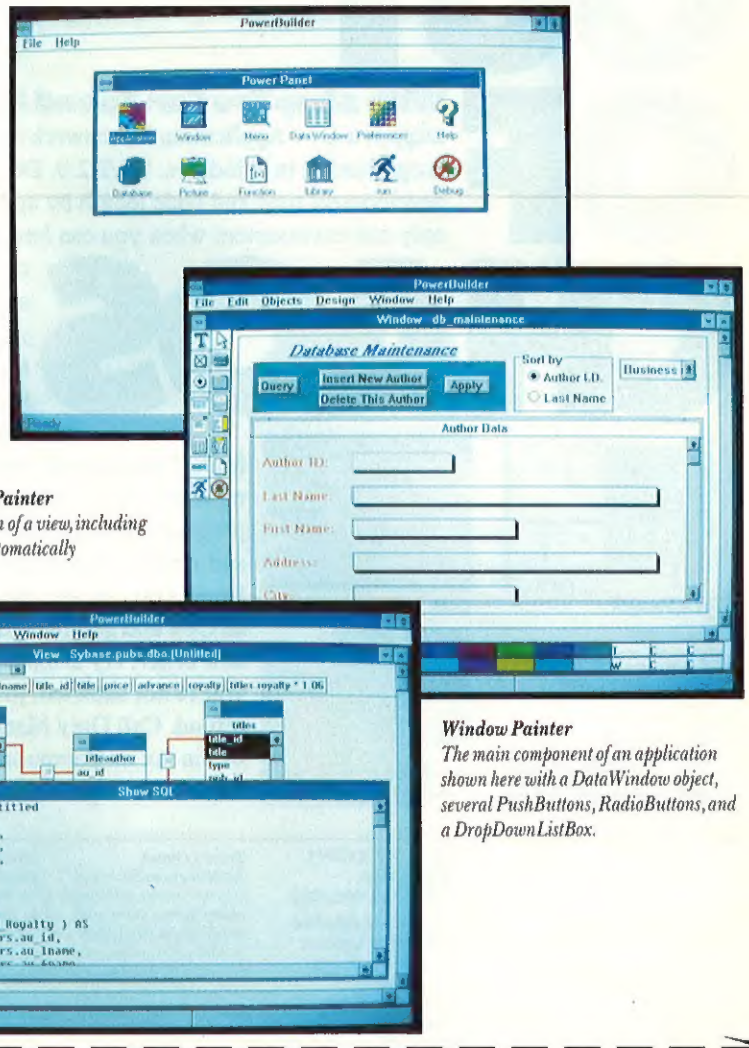

Power Panel
This is a powerful command center for the developer, which provides easy mouse-driven access to the entire PowerBuilder environment.

Database View Painter
Graphic definition of a view, including joins, showing automatically generated SQL.

Window Painter
The main component of an application shown here with a DataWindow object, several PushButtons, RadioButtons, and a DropDownListBox.

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DOSX Born-again

Zortech's DOSX, the 32-bit DOS extender which was shipped with Zortech C++ V3.0, has been re-vamped and is now available from FlashTek under the new guise of X-32. Improvements include a debugger interface which enables developers to perform source-level debugging on the `spawn()`, `system()` and `exec()` system calls. X-32 also has a bigger brother called X-32VM which provides up to 3.5 GB of virtual memory. X-32 is compatible with XMS, VCPI and DPMI and is presently available for the Zortech compiler. FlashTek distributes X-32 together with X-32VM as a single package which costs £60 (no royalties). X-32 is available in the UK from Murray Communications on 0476 74108.

X For DOS

Quaterdeck has unveiled DESQview/X, the latest release of its popular DOS multitasker. Quaterdeck has boldly proclaimed that 'DESQview/X is the first full DOS client/server implementation of the X Windows System'.

There is support for remote computing and Quaterdeck has provided the facility to run DOS text and Microsoft Windows applications remotely on another DESQview/X PC or X workstation. It is possible to cut-and-paste between different windows irrespective of whether the applications within the windows are running locally or remotely. DESQview/X includes the Application Manager, File Manager and the Adobe Type Manager which provides 13 Type 1 fonts for X Windows and enables DOS text applications to run inside scalable windows. Quaterdeck's QEMM386 and Manifest are bundled with DEQview/X.

Support for OSF/Motif and Open Look is also available separately. DESQview/X costs £199 and comes with Network Manager which provides support for Novell Netware and NetBIOS networks.

A Network Manager for TCP/IP is also available at a cost of £149. The OSF/Motif Window Manager is priced at £189. The Open Look Window Manager costs £149. Quaterdeck can be contacted on 0245 496699.

MOT for LAN

LANprobe is a software-based network analyser which can be installed on any PC or AT machine. LANprobe supports Novell NetWare 286, Novell NetWare 386, Microsoft LAN Manager and IBM LAN Server protocols. The menu-driven software is able to capture network traffic in real time and then display the information in a variety of formats, including one which displays an annotated decoding of the protocol packets. The efficiency of the network can be displayed graphically on a PC's screen using bar graphs. It is also possible to use LANprobe to detect unauthorised accesses to the network, without alerting potential hackers.

The software is distributed with a network card which has been programmed to capture all network traffic. LANprobe costs $995 and is produced by General Software on 0101 206 3914285.

Are you Experienced?

Experience for Windows from Expert Edge adds another product to the burgeoning catalogue of Windows application development tools.

The product combines visual design tools with a 4GL-like programming language that can be used to develop database applications. File formats are compatible with dBASE data and index files. There is also support for DLL access from the scripting language and DDE support. The company is planning to provide links to a variety of SQL servers in subsequent releases.

Experience for Windows is currently available at an introductory price of £495 (a saving of £200). A run-time version is also available for £795 (saving £300). Expert Edge is on 081 9417433.

PC Teletext

Tune into the Ceefax and Oracle teletext transmissions with Optimum Technology's OPT-III/S teletext receiver. This external box-of-tricks plugs into a PC's RS232 port and enables you to view pages on-screen, or save the information to disk. By converting the raw data to ASCII, it is possible to load the information into a database or spreadsheet.

The software that comes with OPT-III/S includes a utility to set the system clock to the teletext time, sequencing software which provides a batch file mechanism for automating the process of selecting which pages to view/print, and the OPTIII.SYS device driver which provides a mechanism for controlling OPT-III/S from within your own software. OPT-III/S External Receiver is priced at £295. An internal version is also available at a cost of £195. For more information phone Optimum Technology Ltd on 081 2030220.

Objects of '92

Object Expo-Europe is a new annual exhibition of object-oriented technology, which will take place on 14-17 July 1992 at the Church House Conference centre, Westminster, London. There will be over 40 companies exhibiting OOP products and more than 50 lectures, tutorials and panel discussions. Details of the conference can be obtained from David Lloyd on 071 306 77331.

From C To C++

Bjarne Stroustrup, the father of C++, will be speaking at the C Plus C++ In Action conference at the London Gatwick Airport Hilton on the 8-12 June 1992 in which he will discuss the transition from C to C++. 'In Europe, I have more problems explaining that C++ doesn't have all of C's faults', said Stroustrup, '...even C doesn't have all the faults ascribed to it!' Details of the conference can be obtained from the Boston University Conference Office on 071 2592032.

3 Day GUI

Cambridge Connectivity promise to give one of your character-based UNIX applications a GUI in 3 days or your money back. Using the Soft Option development kit one of the company's engineers will spend 3 days on-site and knock up a windowed version all for £3,950 which includes a copy of the kit (extra copies priced at £2,000). For more information on Soft Option and the current promotion contact Cambridge Connectivity on 0954 51968.

3270 Emulator

Select Windows Client V1.1 is the latest release of Digital Communications Associates' 3270 terminal emulation package for Windows. Select Windows provides up to five 3270 sessions and 64 LU 6.2 sessions. Each session can be displayed in a resizeable window. DCA Select Windows Client V1.1 costs £2,749 for a comms server-based licence. DCA can be contacted on 0442 231414.

Open Look Debug

TauMetric's C++ debugger is an Open Look-hosted debugger for the TauMetric C++ compiler on the Sun SPARCstation. Program information including source code, program I/O and scope information is displayed in one of five windows. There is also a graphical class browser which is able to display instant variables using a point-and click method to dereference pointers. TauMetric's C++ debugger and browser costs £1,200 and is distributed in the UK by Instrumatic Ltd on 0628 476741.

Letters

We welcome short letters on any subject that is relevant to software development. Please write to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. Unless your letter is marked 'Not for Publication', it will be considered for inclusion in this section.

Beer money

Sir,

I am compelled to write to you after a recent software supply experience. The prospective client was a 'computer literate' hotel owner. The client had purchased an integrated accounts package in the dim hope that it would satisfy his requirements. The package was eminently unsuitable for his purposes. This left him wary of software suppliers. In an effort to allay his fears, I produced a system outline documentation and was greeted with, '...anybody could run that off on a word-processor'. Temper in check, I patiently explained that this document provided the basis for an agreement between ourselves which would be referred to and amended as the implementation progressed. Unimpressed, the client changed tack and stated that he could probably get some newly qualified computer person to do the whole thing for 'beer money'.

The point I'm trying to make is that there isn't enough control over software providers and that 'computer literate' is too ambiguous a term. I am a conscientious developer and will only supply software that I know will do the job. I'd rather lose a client than supply to make the sale (poverty doesn't frighten me) - I'll probably lose this one when the hotel owner receives the quotation for a bespoke system I've sent!

Roland Lees
MicroSolus, Motherwell

Too Extreme

Sir,

Regarding the article *Are hackers really criminals?* by David Martin in *.EXE* April 1992. While the factual content of the article was, well, factual, and such an article was certainly necessary, I think if the ranting opinions and vitriol are stripped out of the piece one is left with perhaps only half the number of words.

While Mr Martin is certainly entitled to his opinions, his assumption that anyone who does not subscribe to his views is ignorant or stupid is puerile. His belief that hacking will be stopped by this legislation is simply wrong. Security will still be required, for the same reasons as before.

Mr Martin believes that hacking can and should be eliminated by ever more vicious penalties. In no other part of our law is anything equating to trespass even a criminal offence, but thanks to the CMA it carries a scale five fine. How does he justify this? He then criticises Judge Francis Aglionby for not understanding the reasoning behind the law. Good God, man, I don't understand the reasoning (and neither, if truth be told, does he)!

The CMA, like the DPA, is useless. They were drafted as a response to public worries about banking security, credit references, and the like; being thrown together by other uninformed people they do not address the real issues. Mr Martin, you claim to be an expert. You have a responsibility to inform in a rational manner, rather than to propagate the kind of idiocy and scaremongering that brought the acts into existence in the first place.

Jules May
Herts

Increased privacy

Sir,

Peter Sabine-Bacon's Soapbox article in March's .EXE was in my opinion very much along the right lines. In the final paragraph he states that the technique he proposes does not hide `private` member functions. The solution to this is very simple.

Rather than place the `private` members of a class in a `struct` as he proposes, place them in another class where the `private` member functions can also be declared. His example then becomes:

Public Header File (for distribution)

```
class ObjectImp;
class Object
{
private:
  ObjectImp * pImp;
public:
  Object(int data);
  ~Object();
  int GetData();
};
```

Private Header File (not for distribution)

```
class ObjectImp
{
friend class Object;
private:
  int Value;
  int PrivateFunc();
};
```

Source File

```
#include "<public header>"
#include "<private header>"
Object::Object( int data )
{
  pImp = new ObjectImp;
  pImp->Value = data;
}
Object::~Object()
{
  delete pImp;
}
int Object::GetData()
{
  return pImp->Value;
}
```

I don't claim this idea as mine originally, as I first saw it in the header files for Glockenspiel's CommonView.

Nicholas King
Olivetti Systems & Networks

Paul Kemp replies - actually I wrote the article based on work with Peter. Your proposed extension is indeed an improvement, and I think is a good model for suppliers of C++ libraries and developers alike.

Letter of the Month

The writer of the best letter of the month, as judged by the Editor, will receive a £20 book voucher, courtesy of Just Computer Books. The best letter is the one printed first. Please note that letters submitted to this page may be edited.

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An introduction to OS/2 2.0

OS/2 version 2 is IBM's first truly integrated operating platform for DOS, Windows and OS/2. Michael Price takes a first look for .EXE Magazine.

OS/2 2.0 is IBM's first version of OS/2 to support 32-bit, finally exploiting the full capabilities of the Intel 386 and 486 processors. The flat memory model allows programs to address memory as one single huge address space, and demand paging makes it feasible. However, OS/2 2.0 has not forgotten its origins. It can still run 16-bit OS/2 applications without change. Windows 3 binary compatibility is provided in a protected environment. DOS applications are supported using the virtual 8086 mode, to provide multiple virtual DOS machines. All processes run in protect mode, and the virtualisation of interrupts and hardware access allows even communications programs to run in the background.

OS/2 2.0 still offers full multi-tasking, multi-threaded pre-emptive operation and installable file system support, with HPFS (High Performance File System, an alternative to the FAT-based file system), CD-ROM support and an enhanced version of the FAT file system. And the OS/2 development tool kit has been upgraded and is joined by some new products to help take advantage of the simpler 32-bit programming model. The observations in this article are based on the interim release 6.304E of OS/2 version 2.

Installing OS/2 2.0

When you acquire a new operating system for a machine, the first down-to-earth practical consideration is fixed disk organisation. The simplest approach is to install OS/2 2.0 as the main operating system on a single partitioned disk. This is the simplest approach and is used when OS/2 2.0 will be used all the time. It does give the option to boot DOS, either through dual boot (with FAT formatting) or as a 'guest' system.

OS/2 2.0 also supplies a boot manager facility which gives up to three alternative primary partitions, each with a separate operating system (eg MS-DOS 5.0, OS/2 1.x and OS/2 2.0). Of course, only one of these partitions can be active at any one time, so files cannot be shared between the separate systems. The boot manager needs 1 MB of disk space at the start or at the end of the fixed disk. As long as there are no more than three primary partitions, the remaining disk space can be divided into one or more logical partitions that stay accessible. Each operating system can access the files in the logical partitions, so it is possible to share, for example, the SWAPPER.DAT file between OS/2 1.x and OS/2 2.0.

As well as the many partitioning options, OS/2 2.0 is equally generous in its options for actually installing the code. As usual, the product can be installed from diskette, either 3.5" or 5.25". The installation must be from the boot floppy drive. The improved installation process appears to work faster, and effective use of graphics illustrates the progress of the installation. However, with twenty diskettes for the base version, and more again for extended services, this can be a long and tedious process.

The installation is heavily tailorable. A minimum system takes less than 20Mb of disk space, while selecting all the optional features, including reference books and additional fonts, takes in excess of 40Mb of disk space. OS/2 2.0 offers some pre-defined selections, or a free choice, and it is possible to go back later and add any features that may have been missed the first time round.

OS/2 2.0 includes a migration database that includes specifications of various DOS, Windows and OS/2 programs. This enables the system to search for all matching applications on any of the accessible drives, and place them in folders on the OS/2 desktop, with the appropriate settings. A custom version of the database file can be created, to ensure that required applications get added automatically.

The Desktop

The appearance of OS/2 2.0 is different from any of the previous PC operating environments. In the workplace shell, everything is on one screen, the desktop (Figure 1 - Desktop and Folders). There are four types of object associated with the desktop - data file, program, device and folder. The folder is a container for other objects, and the desktop is itself a special folder that fills the entire screen.

When OS/2 2.0 is installed, the desktop is created with some initial folders, including OS/2 System, Information and Templates. Additional folders will also be created with migration of existing Windows or DOS applications, or installation of additional components such as the extended services (for database or communications functions).

Each object has an associated pop-up menu, displayed using mouse button 2. This offers copy, move or delete functions for the object. Opening the object gives access to an additional menu through which the characteristics of the object can be set or changed. Double clicking with mouse button 1 starts program objects. It is also possible to associate programs with specific data file types (for example, .DOC files could be associated with DW5/2) and then double clicking on the data object will cause the appropriate program to be started. By default, data file objects will be associated with the system editor.

This new way of working may be too much of a change for some users who are used to a particular environment. For these, OS/2 2.0 offers the option to make the system look like OS/2 1.x or Windows. It is necessary to boot the system from an OS/2 diskette (typically Install diskette #1) in order to modify the OS2.INI file. The modification is done by running the MAKEINI program from the \OS2 directory; the command

```
MAKEINI OS2.INI OS2_13.RC
```

produces the appearance of OS/2 1.x when the machine is next booted from fixed disk, while

```
MAKEINI OS2.INI WIN_30.RC
```

starts a Windows 3 emulation.

These procedures provide the appearance of the selected operating environment, but not the functionality. They will however make it easier for users to find the facilities they require.

OS/2 applications

Normally OS/2 applications will be installed as program objects on the desktop or in appropriate folders and started using the mouse buttons or the drop-down menus. However, OS/2 applications may also be started from an OS/2 command line.

The OS/2 System folder contains a Command Prompts folder which, in turn, contains icons for full screen or window OS/2 sessions. When one of these is selected, the appropriate session is started, permitting applications to be initiated from the OS/2 command line provided.

Re-selecting the OS/2 prompt icon (which will be shaded to show it is in use) will merely switch the focus to that session. To start additional OS/2 sessions, copy the icon into the same folder or a different folder, and then start that new icon. There can be many OS/2 sessions, subject to the limits of the available memory (although the new paging approach to virtual memory allows a much higher level of overcommitment than previous versions).

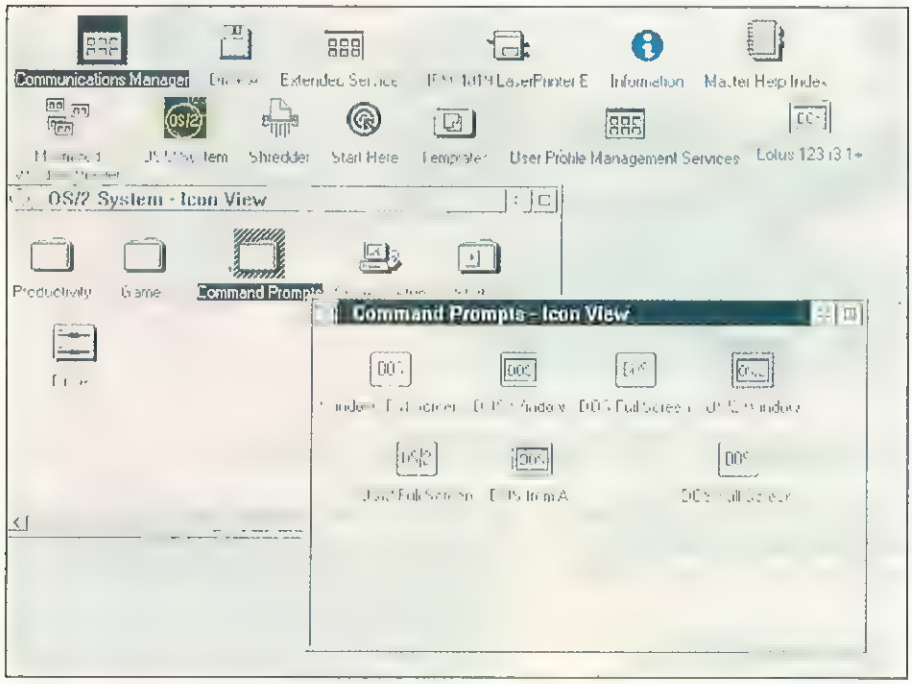


Figure 1 - Desktop and Folders

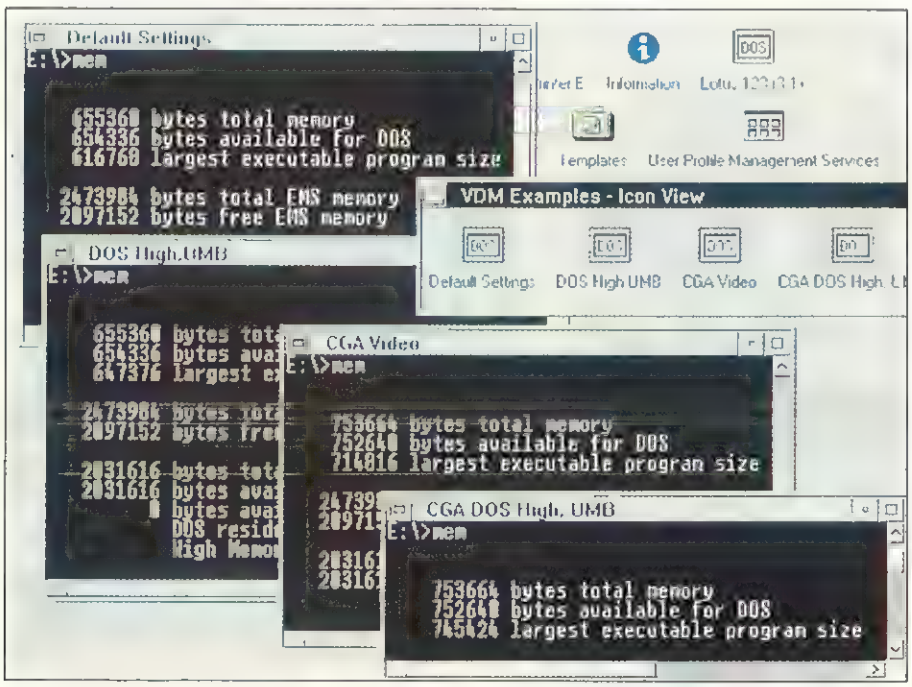


Figure 2 - Virtual DOS Machines

Running DOS

The Command Prompts folder also contains icons for full screen or window DOS sessions. These are virtual DOS machine (VDM) sessions which utilise the virtual 8086 mode of the Intel 386 and 486 processors. There can be up to 240 DOS sessions defined. As with the OS/2 sessions, additional VDMs are accessed by duplicating the icons. Alternatively, to start applications from the desktop or a folder, you can associate program objects with DOS full screen or window sessions

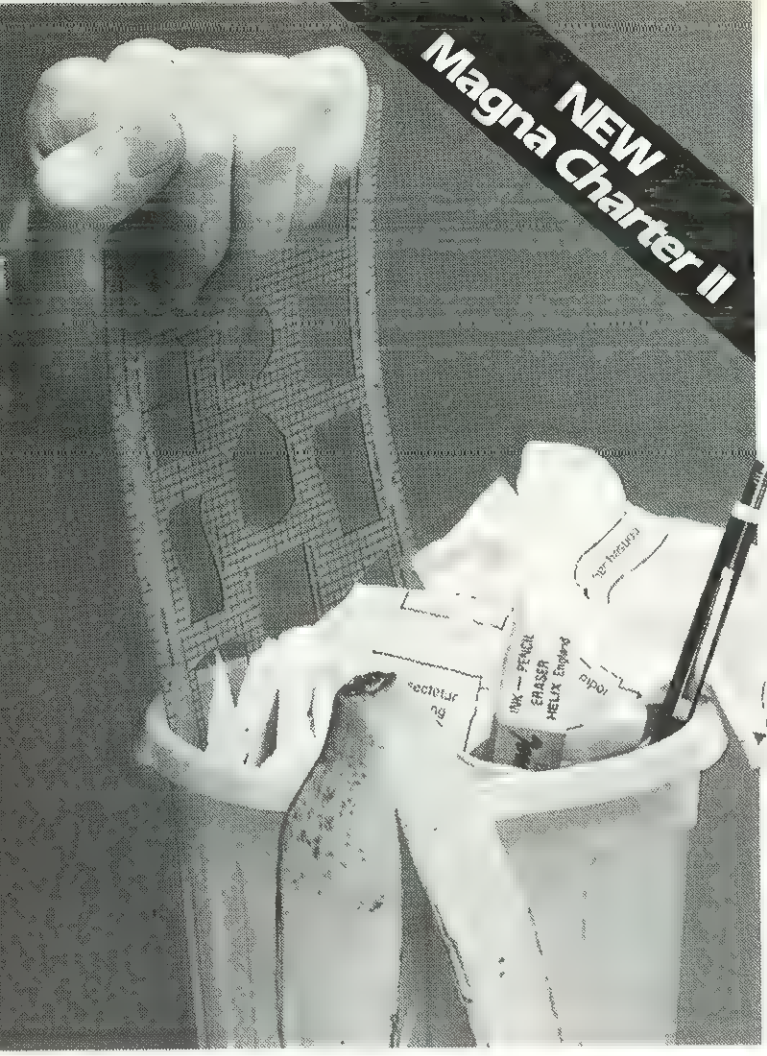
The VDMs can be extensively tailored to suit the requirements of particular applications. There are settings for the keyboard, mouse, and printer, and a range of settings for memory, including DPMI, DOS high, DOS size, UMB, EMS and XMS. Controls for video include mode, memory allocation, retrace, ROM mapping and window refresh. Other settings of interest are the startup drive, version data, and background execution.

These DOS sessions bear little resemblance to the OS/2 DOS box of old. As well as having multiple sessions, OS/2 2.0 relieves the severe memory constraints. With the default settings, VDM sessions will make 602 KB out of 640 KB available. With settings of DOS high and UMB this rises to 632 KB, with over 40 KB of free UMB space also available (see Figure 4 - Virtual DOS Machines). Moreover, all this space will normally stay available for programs, whatever device drivers are needed, since the devices will actually be supported by OS/2 device drivers linked to virtual DOS device drivers.

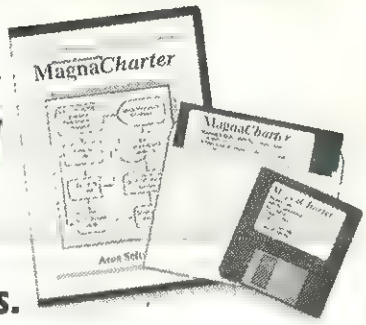
If this is still not enough, restricting the video mode to CGA will allow a DOS session of 736 KB, of which 698 KB is available for applications. With CGA, DOS high and UMB, programs can be as large as 728 KB.

Windows

Windows applications can be started from an OS/2 session merely by typing the application name. For example, typing WINWORD will launch Word for Windows in a WIN-OS2 session. Kernel support for Windows is included in OS/2 2.0 and it can run existing Windows 2.x and Windows 3 (standard mode) applications unchanged. Windows 3 Enhanced mode is not supported; IBM says this is not a problem, because the extra facilities (extra memory, multiple DOS sessions etc) offered by that mode are duplicated by OS/2 itself. Pro-



Out with the Old In with the New



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gram objects for Windows applications can also be defined, as for DOS and OS/2 applications. Windows programs may be run in full screen sessions, or in their own OS/2 desktop windows.

There are some graphics mode restrictions running DOS and Windows applications. Only full screen Windows sessions are supported with an XGA adapter with the desktop installed as XGA. Some applications may also be suspended when in the background. WIN-OS/2 does run on systems with VGA adapters, or with XGA adapters where the desktop is installed as VGA.

DOS Versions

There may be need for a specific DOS version to run a program that does not run correctly in DOS emulation. For example, if a DOS program uses a device whose driver does not load into an emulated DOS session, a real DOS session will be required.

The first step is to create a method for starting the specific DOS version. This can be a bootable diskette, a DOS partition on drive C, or an image file on fixed disk.

The path and file name of the specific DOS must be entered in the DOS startup drive setting. The FSFILTER.SYS must be included in the CONFIG.SYS to give access to the OS/2 file systems. These requirements are described in detail in the general help facility provided on the desktop. This approach will load any kernel that would run on the 8086 processor, including, for example, MS-DOS 5.0 or DR DOS 6.0.

Programming Tools

The IBM OS/2 2.0 developer's toolkit provides a comprehensive selection of language-independent build tools, productivity tools and sample programs, on-line reference information and a kernel debugger. This toolkit can be used with the IBM WorkFrame/2, which is a configurable project-oriented application development environment featuring an SAA/CUA conforming user interface. It is built with an open interface to serve as the integration point for the tools in the developer's toolkit as well as tools supporting C and other languages.

IBM continues its move away from the Microsoft camp with C Set/2, a 32-bit SAA C compiler with run-time libraries, which generates native code for OS/2 V2.0. It also includes a fully interactive, full function, source level PM debugger. For 16-bit developments, existing compilers and tools can of course continue to be used. WorkFrame/2 allows both 16 and 32-bit OS/2 tools to be plugged in.

There will also be an OS/2 2.0 version of the System Performance Monitor/2, an integrated package of performance monitoring and analysing facilities. SPM/2 enables developers to monitor and verify performance objectives, to analyse problems and as an aid for tuning and load balancing. SPM/2 can be run on a stand-alone machine, when data is usually captured for later analysis. It can also operate across a LAN, and in this case the captured data can be displayed in real time on a separate machine.

With CGA, DOS high and UMB, programs can be as large as 728 KB

Applications design

OS/2 2.0 takes full advantage of the 386 processor flat memory model and paged virtual memory. This means that applications do not have to manipulate selectors and offsets, but can view memory as a large, linear address space addressable by 32-bit offsets from the start of memory.

OS/2 2.0 provides different names and entry points for all 16-bit and 32-bit APIs, which makes it possible to mix 16-bit and 32-bit code and calls within a single EXE module. Only 16-bit or only 32-bit APIs can be used in a single C module however, because of include file support. The same type names are used in both environments. For example, take a statement such as:

```
LAB buffer = "hello";
```

In the 16-bit environment this is expanded to:

```
char far *buffer = "hello";
```

but in the flat model 32-bit environment, where everything is addressable, this becomes:

```
char *buffer = "hello";
```

The 32-bit memory layout of OS/2 2.0 is accomplished on the 386 by creating a very large segment, which can be up to 4 GB in size. A code segment and a data segment are mapped onto this segment, and `near` addresses are used throughout. Two flat selectors are used, and the base addresses of these are always zero, giving 0:32 referencing.

To make things compatible with 16-bit applications, tiling is used to map the area into 64 KB regions. The maximum address in the tiled memory region is 512 MB. The addresses are referenced using 16:16 addresses. The first 512 MB of the OS/2 2.0 virtual address space forms the compatibility region.

Technical library

The new version of the OS/2 operating system is copiously documented. There is an *Application Design Guide*, three volumes of the *Programming Guide*, three *Device Driver Development* publications, two REXX manuals and two SAA CUA manuals. Available in both hard copy and 'on-line' form are the *Control Programming* reference, three volumes of *Presentation Manager* reference, the *System Object* manual and the *IPF* manual.

These manuals are aimed at the professional programmer, and they deal with migrations from 16-bit to 32-bit as well as from DOS or Windows. All this material is additional to the manuals provided with OS/2 2.0 and associated products.

For the independent software developer, further help is available from IBM's developer assistance programme. This offers a range of facilities including OS/2 products and publications on CD-ROM, an electronic bulletin board service, and specialist workshops to aid in porting and testing 32-bit applications. This programme is run from the UK and provides cross-Europe support.

Summary

This has covered just some of the features of the new version, but it may begin to show that OS/2 2.0 is not just for OS/2 developers. DOS and Windows applications can run just as well in this new environment. When building new applications, the multiple, large memory, protected mode and independent sessions could be a positive boost to development productivity, whatever the target.

EXE

Michael has worked in the mainframe environment for many years, in technical and development roles, and switched in the early eighties to the architecture and design of systems based on PCs and local area networks. Currently, Michael is a systems design consultant in the financial industry arena.

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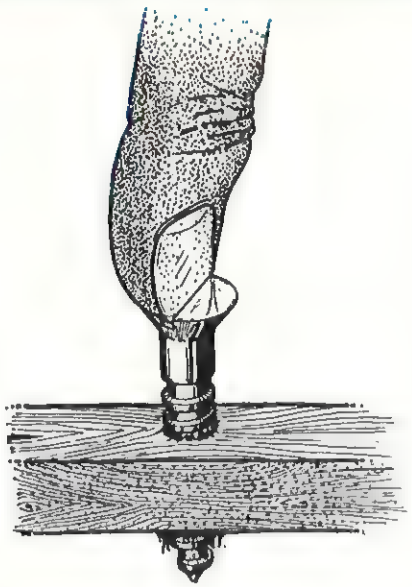

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Positioning OS/2 2.0

OS/2 1.x failed because of 286 code. Windows 3.0, the current favourite, is technically unsound; it must be superseded. Martin Healey wonders which will inherit the mantle: OS/2 2.0 or Windows NT?

The original concept of a PC for individual personal computing is still valid, particularly with portables, but the corporate world is now seeking to integrate users. This is done by interconnecting PCs using LAN technology, the PC acting as a workstation (the client). Shared resources, in particular files, databases, print spoolers and communication gateways reside on one or more servers. PC hardware can also be used for the server but this role will soon be transferred to RISC-based hardware, which is far more cost-effective for larger servers.

The essential difference between a personal computer and a workstation is that the latter must include communications functions with its operating system, while communications is an application on a personal system. The connectivity services of the workstation software should be transparent to both user and programmer and should be robust (protected mode). Thus a 386 PC with MS-DOS is a personal computer while the same hardware with OS/2 or UNIX is a workstation by the above definition.

MS-DOS versus the Mac

The inadequacy of the character-based user interface of MS-DOS has been sharply brought into focus by the Apple Macintosh. The Mac provides a consistent environment for applications, while all DOS programs are different, resulting in excessive training and support costs. Furthermore, multi-session working is a natural enhancement to any user interface (virtual screens on CDOS or UNIX), which can be enhanced if independent sessions can be activated in graphical windows. This was the advancement offered by Mac Multifinder and on the PCs by Windows 3 or DESQview (in contrast to Windows, Windows 2 and GEM which only provided multiple windows to the one program). Once multi-session, windowed interfacing is established, the well known enhancements such as cut-and-paste, drag-and-drop and icon driven commands become particularly effective.

Unfortunately, the combination of transparent communications services and multi-session working requires a rather sophisticated operating system, preferably one with true pre-emptive scheduling and multi-tasking. The primary examples of this were the enhanced UNIX executives developed for engineering workstations, eg SunOS, HP/UX or AIX. The engineering workstations and the Mac never suffered from MS-DOS, the epitome of single-tasking software, and hence provide excellent workstation/network solutions.

Because of the existence of MS-DOS and MS-DOS applications, there have been many brave attempts to create networked systems which provide some continuity. These fall into two classes: a) DOS workstations with a shared file server, dominated by Novell Netware and b) multi-session, windowed executives on top of DOS, dominated by Microsoft Windows 3, but better implemented by DESQview. The sooner it is recognised that mounting executives on top of DOS, of any sort, is only a short term solution, the better. These products are expedient at best; they partially solve the user interfacing and networking problems but, because of the lack of protected mode software, they create even bigger problems with support and training.

Continuity

Having invested in DOS applications, users are loath to throw them away. So the full

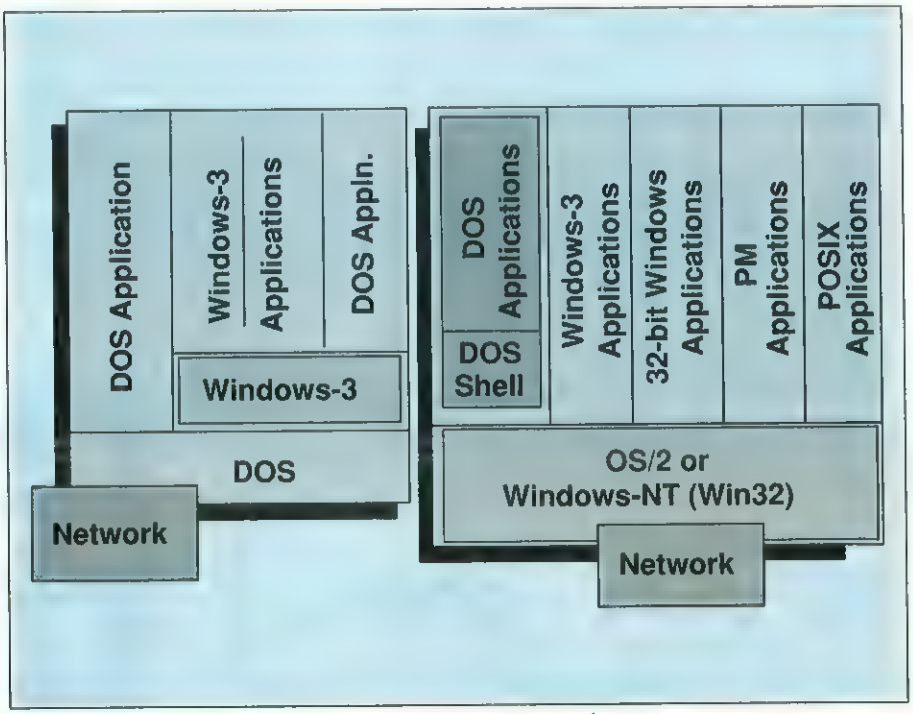

Figure 1 - Workstation OS Architectures

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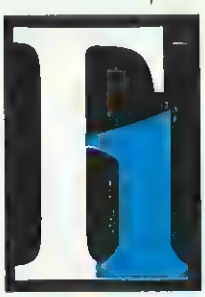

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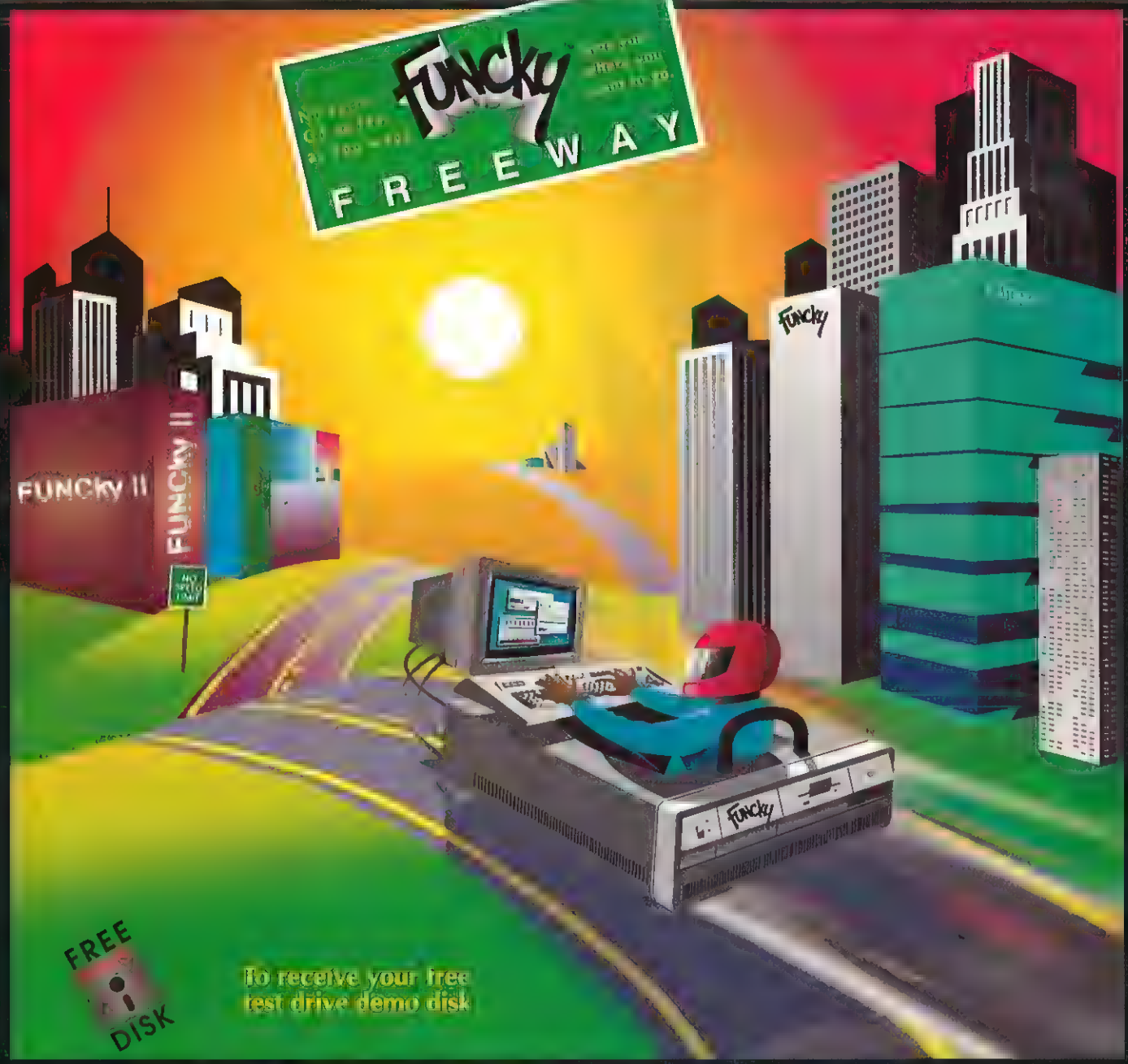

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CIRCLE NO. 915

requirement for an operating system to convert the PC hardware from personal computer to workstation is a multi-tasking, multi-session, windowed system which will execute existing DOS programs alongside new applications. This constraint is a strategic mistake for which we are paying dearly, although it is an understandable mistake.

The first problem encountered was that the memory manager of the 286 is inadequate to run virtual 8086 sessions and so a 386 SX is the minimum hardware requirement.

The second problem with running DOS programs in a windowed environment is that they are still all different. It is only properly written programs that will integrate and hence reduce training and support costs. In the end it is cheaper to throw the DOS programs away and to replace them with consistent, integrated equivalents.

Client/Server Systems

While UNIX derivatives have been successful for engineering workstations, they consume considerable resources. There is also a fear of UNIX and its user hostile interface (no worse than PC DOS, but believed to be so) so that it has been rejected for desktop PC applications. Users wanting UNIX on a workstation are better served by low end RISC machines. UNIX on a PC is dominant for multi-user, VDU-based systems, particularly small business systems.

Since IBM and Microsoft controlled the PC market with MS-DOS, and this suited software vendors such as Novell, Lotus, Borland, and so on, progress was stopped for most of the 1980s. Mass advertising brainwashed PC users into accepting inferior products (excellence in mediocrity) despite the lessons taught by the Mac, Sun, etc. But the need to integrate workstations with data bases reached most corporate users attention by the end of the 80s, heralding the current interest in client/server computing, with both PC, UNIX and mainframe database servers.

File serving is adequate for 'multiple single-user' personal computing, but corporate requirements involve multi-user, groupware etc and must provide shared database services. SQL requestors are available for MS-DOS and DOS + Windows 3, but this unprotected conglomeration of software entities posing as an operating system is technically unsound. It can never be made safe against erroneous application software and thus can never be made acceptable.

Despite claims to ongoing development of DOS/Windows, this is mythology. It must be replaced by a properly designed OS, which is now possible due to the working memory manager of the 386/486 family of processors. The memory manager is the most important feature, but the power and the 32-bit linear addressing will make native applications far superior and far cheaper than DOS equivalents.

OS/2

The first attempt to provide the industry standard PC operating system, OS/2 version 1, was a complete failure. IBM and Microsoft may be the best marketing companies in the world, but their technical competence leaves much to be desired. The product was based on the wrong processor, the 286, and failed to provide any usable desktop front-end or any programming tools worth having. It wouldn't run DOS programs, and there were few OS/2 1.x programs and no tools to write them with. IBM provided the GUI with Presentation Manager to embed in the basic OS, but then attempted to ship a proprietary version, OS/2 extended edition, by adding the communications and database managers.

The folly of the 286 processor design was quickly realised and work began on the 386 (32-bit) version 2. Beta versions were tested as far ago as April 90 (Byte Magazine). With no real knowledge of what actually happened it appears that Microsoft's OS/2 2.0, even though they had shipped a beta version, didn't work and IBM took over development.

Microsoft reacted to the loss of OS/2 (and its future!) by releasing its 'poor man's Mac' equivalent, Windows 3. By wooing clone makers, who hoped to sell the 4 to 6 MB memory upgrades Windows 3 needs, it has been an enormous success for Microsoft. At the same time it is a potential disaster for the corporate users, since its technical shortcomings are not solvable and thus it will result in even more expensive PC systems. Windows 3 does provide superior facilities to DOS and thus specific Windows 3 applications are desirable. As a result the requirements for the real PC operating system must now include the ability to run 16-bit Windows 3 applications as well.

Thus, very late in the day, April 92 represents a milestone, if IBM has got the product technically right, ie it is robust, performs well and is economic. OS/2 2.0 provides the system users want; ask a committed Windows 3 user to describe what he or she wants from the system and they will accurately define OS/2 2.0, not Windows 3.

Windows NT

Despite its current euphoria over Windows 3, Microsoft is not stupid. It has brilliantly sold an inadequate software package, which must be replaced. Those users who say they won't upgrade should think of how users weren't going to upgrade from XTs to ATs or from 286 to 386 machines - but they did. Thus there are 10 million and more replacement operating systems to be sold, which will likely be OS/2 2.0. Microsoft has predictably reacted by talking

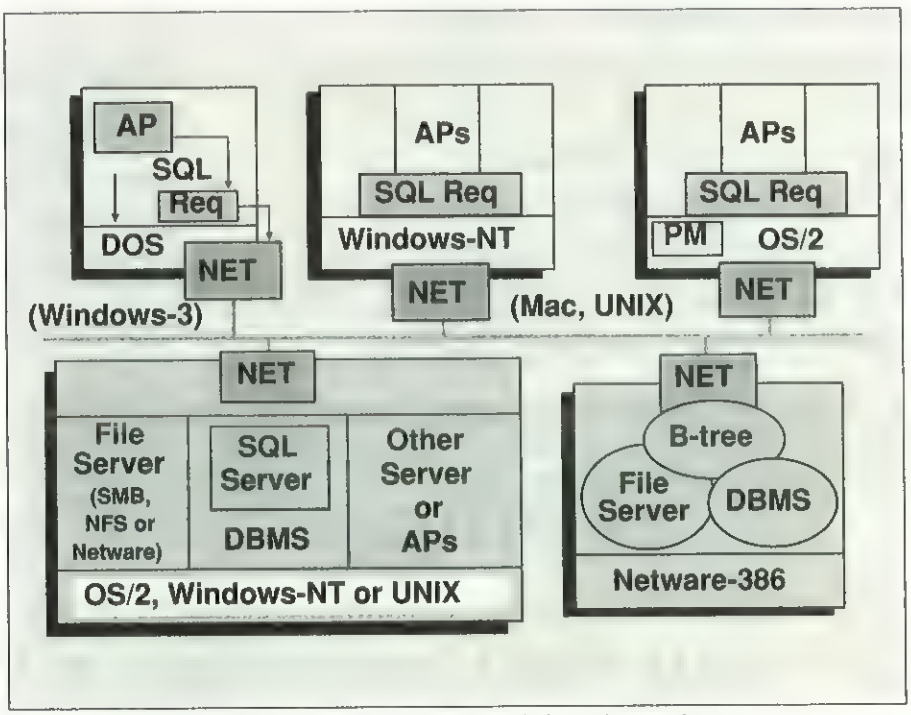

Figure 2 - Third Generation (Client/Server) LANs

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PC-lint 5.0 presents C Bug # 564

```
int C_greater_than_Cplusplus( int C )
   {
   return  C > C++ ;
   }
```

Although this looks like a comparison of two well known programming languages, it is really a C function with a subtle error. Can you or your compiler spot it? Call if you need a hint. Refer to Bug #564.

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CIRCLE NO. 916

about Windows NT, which it hopes will slow down the take-up of OS/2 2.0 and then win the bulk desktop workstation market.

Windows NT is well specified. It is based on microkernel technology, akin to Mach (as adopted by OSF) and Chorus (UNIX V.4), which means that it can support multiprocessors, guest operating systems, specialised servers etc. Two initial versions are proposed, one for the Intel 386/486 and the other for the MIPS RISC processor, part of the dubious ACE consortium. A specific version of Windows NT, possibly called Win32, will vie with OS/2 2.0 for the PC workstation, but other versions will vie with UNIX for server and engineering applications.

With Windows NT Microsoft are really taking the whole world on, head on.

Microsoft Versus IBM

A key aspect of the OS/2 2.0 market is the alliances that keep cropping up in our disjointed industry. Now that IBM have fallen out with Microsoft, which can only be to the good of the industry, Microsoft is looking to other partners who are antagonistic towards IBM. DEC is the current target to replace IBM in the Microsoft camp, a significant player, but an ailing one and still nothing like as big as IBM. DEC is making noises about an interest in Windows NT, but it is also rumoured to be lining up with IBM for OS/2 2.0 (backing both horses, in line with the Japanese and most others). In fact, DEC is particularly interested in Microsoft Lan Manager, the basis for Digital Pathworks, rather than any specific OS.

In the 1980s Microsoft could, and did, produce any product, which backed up by IBM couldn't fail to succeed. The unholy alliance was a virtual monopoly. Now Microsoft must not only make it alone but in competition with IBM.

Conclusion

Unless IBM has made a mess of OS/2 2.0 technically, it will surely succeed in its own backyard: the corporate IBM die-hard mainframe sites. They need OS/2 2.0 to gain client/server computing in an SNA world with a mainframe DB2 database.

But IBM must be favouring winning the bulk of Microsoft's considerable revenues by dominating the DOS and Windows 3 replacement market. To do this it must woo all PC clone suppliers, including rivals such as DEC and H-P, in direct competition with Microsoft. This implies a completely new PC sector stance from IBM. Gone is the concept of a 'vertical' proprietary PS/2 loaded with OS/2 EE workstation. IBM must commit that there will be no specialised IBM versions of OS/2 2.0 and the PS/2 must compete as it does today as another PC.

IBM has also made strategic alliances with key PC industry software suppliers Novell, Lotus and Borland. They will be shipping true 32-bit OS/2 2.0 versions of their products which will inevitably be superior to the 16-bit Windows 3 versions. Only Microsoft will be favouring Windows NT over OS/2 2.0, although everyone will once again back both horses, just in case OS/2 2.0 fails.

One key to the success of OS/2 2.0 must lie with the wealth of applications available for it. In sharp contrast to OS/2 1.x, which had no applications, OS/2 2.0 will have all the DOS and Windows 3 programs plus the new 32-bit versions. There are also numerous tools, eg Choreographer, Smalltalk V, for developing in-house applications.

The ideal solution for everyone will be a choice of OS/2 2.0 or Windows NT, with relief from Windows 3, by the end of 1992. A choice of two operating systems leads to competition and ongoing improvements, as demonstrated in the UNIX world by the success of OSF/1 versus UNIX V.4. Unfortunately serious doubt must be placed over the possibility. OS/2 2.0, yes, but can Microsoft get Windows NT beyond the beta stage? Its track record says it will be two or three years yet before it has an acceptable release, by when it will be too late. It would be foolish and naïve to believe any of Microsoft's claims; it is beholden to prove that it can, for once, meet its claims.

By the end of '92, my preferred LAN system will be DOS (286) and OS/2 2.0 (386/486) workstations with UNIX servers on RISC hardware, using TCP/IP protocols. I will favour a strategy based on the replacement of existing LANs, rather than one based on continuity.

Finally: Dear IBM, please could we have a new name. OS/2 2.0 is a mouthful and could be confused with that awful Microsoft product OS/2 1.x, which is better quickly forgotten!

EXE

Martin Healey is Chairman of Technology Concepts Ltd, Emeritus Professor of The University of Wales and Vice President of the Institute of Data Processing Management.

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CIRCLE NO. 918

CodeBase++

How do you provide a consistent C++ interface to your C library? Paul Kemp finds out what Sequiter Software did with CodeBase.

Way back in March '91 Bryan Boreham wrote an article in *.EXE* entitled *Adding a C++ front-end.* As a C++ programmer using a C-based library, he described the design and implementation of a number of C++ 'wrapper' classes to furnish the CodeBase 4.0 library with an object-oriented interface.

CodeBase itself has come a long way since then, and in version 4.5 Sequiter Software has included its own C++ interface. As library vendors are under increasing pressure to provide support for the rapidly expanding C++ market, how has Sequiter fared in its attempt to design 'A Library For All Seasons'?

C++ class name	*C structure name*	*Description*
c4Code	C4CODE	Global settings
d4Data	D4DATA	Data file information
d4Date	None (char[8])	Date information
f4Field / f4Memo	F4FIELD	Fields
i4Index	I4INDEX	Index file information

Figure 2 - C++ classes and C structures

Overview

CodeBase is a comprehensive library of some 185 C functions that allows programmers to create, interrogate and update dBASE files. Version 4.5 of the library supports the dBASE III, IV, FoxPro 2 and Clipper 5 data, index and memo file formats. For dBASE IV compatibility you can choose to use multiple tag (.MDX) indexes, and for FoxPro 2 the new compound (.CDX) index files.

The library is written in ANSI C and full source code is provided, so that it is possible to port the code between DOS, Windows, OS/2 and UNIX simply by recompilation. Semi-automatic record and file locking capability is also built into the library so that it can be used in any number of network environments (eg Novell, 3COM, LAN Manager and UNIX).

Most standard C and C++ compilers are supported including Microsoft, Borland, Zortech and Watcom. There are pre-built libraries for the most popular compilers but it is relatively trivial to build your own custom libraries with batch files that are provided (I was using Borland C++ 3.0 and had to rebuild the supplied Borland libraries because they were created using version 2.0). Support for Visual Basic and Turbo Pascal for Windows is achieved by the provision of a Windows DLL.

dBASE itself is not required so that standalone applications can be built, and there are no royalties; executables and the CodeBase 4.5 DLL can be distributed free of charge.

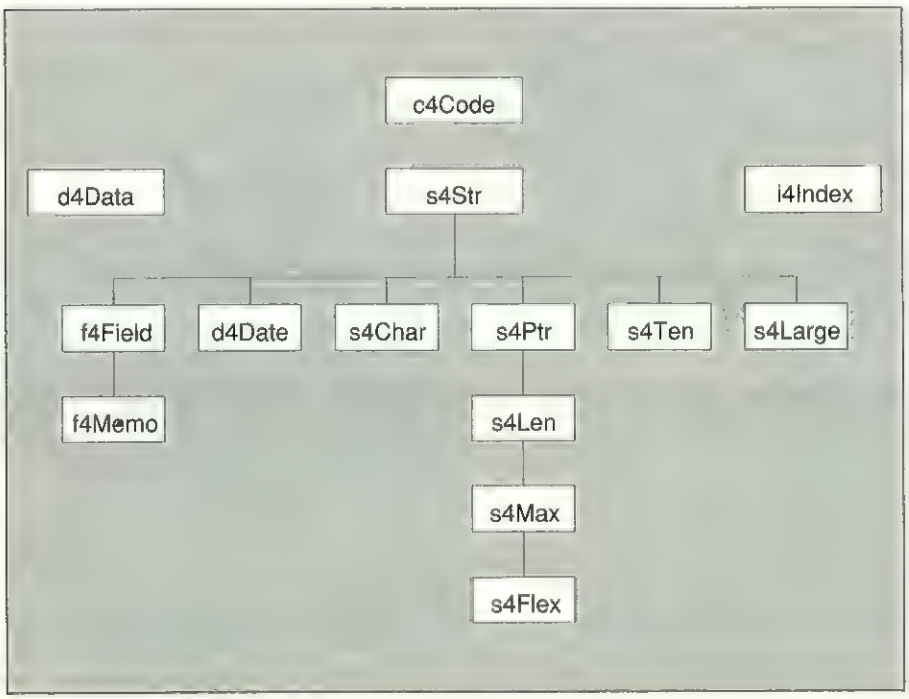

Figure 1 - CodeBase C++ class hierarchy

The C++ interface

Figure 1 shows the CodeBase C++ hierarchy. In an otherwise excellent set of documentation, I was somewhat miffed to discover that such a simple representation of the hierarchy was nowhere to be seen. I have noticed the absence of such diagrams in the documentation of some other C++ libraries and have to say that I find it quite unforgivable; it is the starting point for a C++ programmer getting to grips with a new library.

The CodeBase C library is designed in an 'object-oriented C' fashion that has become

```
#include <d4all.h>
#include <d4data.hpp>

F4FIELD_INFO cust_fields[] =
{
  { "NUMBER", 'N', 8, 0 },
  { "NAME",   'C', 20, 0 },
  { 0, 0, 0, 0 }
};

char * namelist[] =
{
  "Major",
  "Kinnock",
  "Ashdown",
  "Sutch"
};

void main()
{
  c4Code c;
  d4data d;

  // create CUSTOMER.DBF
  d.create( &c, "CUSTOMER", cust_fields );

  d.append_start(0);
  f4Field number( d, "NUMBER" );
  f4Field name( d, "NAME" );

  // append records
  for (long i=0; i<4; i++ )
  {
    number.assign_long( i, -1 );
    name.assign( namelist[i] );
    d.append();
  }

  // print records
  for ( d.top(); !d.eof(); d.skip(1) )
  {
    printf("\n");
    for ( int j=1; j<=d.num_fields(); j++ )
    {
      f4Memo field( d, j );
      printf( " %s", field.str() );
    }
  }
}
```

Figure 3 - Create any print file

more popular in recent years. Most of the functions are grouped in such a way that the first parameter is a pointer to a `struct` which contains all the basic information that the function needs. This type of design facilitates the provision of a C++ interface as the data structure corresponds to a class' `private` data items, and C++ takes care of the pointers with `this`. Figure 2 shows the relationship between CodeBase's C++ classes and its C data structures. For example, the C code fragment

```
C4CODE c;
e4exit_test( &c );
```

in C++ becomes

```
c4Code c;
c.exit_test();
```

Except for class `f4Field`, member functions of the C++ classes are inline calls to the corresponding C function, so .EXE sizes and performance should be approximately the same as using C.

However, there is more to C++ than data abstraction, and it is inevitable that any C++ hierarchy that is based on an existing C library will suffer because it is limited in the number of object-oriented features that can be employed. This is certainly true of the CodeBase C++ interface but, having said that, the company has done a pretty good job.

Fields and records

Where a C++ programmer gains the biggest advantage is in the use of the `s4Str` component hierarchy. Because the `f4Field`, `f4Memo` and `f4Date` classes are all derived from `s4Str` they can be treated as strings. So instead of having to use myriad C functions to manipulate field data, operator overloading and function overloading have been used to good effect in simplifying application code enormously. Figure 3 shows a simple application which creates, populates and lists the contents of a .DBF file called 'CUSTOMER'.

For each data file opened, CodeBase allocates memory for one record worth of information. Each of these memory areas is called a 'record buffer'. Many of the high-level functions, such as `d4Data::go()` and `d4Data::skip()` automatically use this memory buffer. It is the field functions which manipulate information in the record buffer. If data in the record buffer is changed, CodeBase flags the record as having been modified and automatically writes the changed information back to the data file when the contents of the record buffer are flushed (eg by reading the next record with `d4Data::skip(1)`). The following code fragment assigns 'Bobby' to the NAME field of the first database record in file 'CUSTOMER':

```
c4Code c;
d4Data d( &c, "CUSTOMER" );

d.top();
f4Field name( d, "NAME" );
name.assign("Bobby");
d.skip(1);
```

CodeWindows

Bundled with CodeBase 4.5 comes version 1.0 of CodeWindows. It comprises a set of Windows-specific C functions that greatly ease the writing of data entry, edit and browse windows. Dialog boxes are designed in the normal way and control IDs are then linked to database fields in the application. The CodeWindows functions then do most of the hard work for you so that simple applications can be put together in minutes. Picture templates and user-defined validation functions can be defined for edit controls and a basic print module is also supplied.

I was very impressed with this part of the library although, unlike the standard database functions, there is not yet a C++ interface. When this is provided it will prove to be an extremely powerful tool.

Conclusion

CodeBase 4.5 is one of the most flexible libraries that I have come across. Through good design, Sequiter has managed to put together a set of functions that can be used on a wide variety of platforms and in many programming environments. To be sure, compromises have been made, but these have been kept to a minimum through the application of object-oriented techniques. CodeBase is not an object-oriented database - it is operating on dBASE files, but the C++ wrapper works well and sets a good example for other C library vendors.

EXE

CodeBase 4.5 with CodeWindows 1.0 from Sequiter Software is distributed in the UK by The Software Construction Company (tel 0763 244114) priced £255 + VAT.

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In 1992, the power of C++ dominated the known programming world. All the world? Not quite. For in a small Gallic village... Willie Watts talks to chief Eiffel Druid Bertrand Meyer.

Can you give us a sketch history of yourself and Interactive Software Engineering?

I am originally a pure product of the best that the French system has to offer in terms of general, scientific and engineering education. This was completed by an MS in computer science at Stanford in the US.

At Stanford I didn't have enough time to learn much in detail, but I learned what was important and what was not. So that after that I was able to read a lot and learn by myself. I was already working in industry, but at least what I learnt what was important from Knuth, McCarthy and a few people like that. I also learnt about object-oriented technology at Stanford. I was fortunate enough to run into a description of Simula and it struck me right away as the way to program.

After that I came back to France, and went to work for a company called 'EDF', which is the equivalent of what the Central Electricity Generating Board used to be in Britain. I was head of a group which was in charge of software engineering, programming education, software engineering tools, libraries and also links with research in software engineering.

I had a kind of dual role - partly operational (very operational, actually), but also at the same time research. The non-academic side involved, among other things, setting up a training programme on modern software methodology, which opened my eyes to the reality of industrial software development. At the same time I was quite active in research in programming methodology. I wrote a book called *Méthodes de Programmation*, ie 'Programming Methods', which was very important for me and was also quite influential in France. It was used in the main educational institutions, and it put me in contact with professors.

Bertrand Meyer and Eiffel

With the current plethora of object-oriented languages and tools, and C++ apparently set to conquer the Universe, the reader might reasonably ask why *.EXE* chooses to devote so much space to the inventor of yet another language - a language which is still comparatively unknown in the wider programming community.

The answer, in a nutshell, is Meyer's book *Object-Oriented Software Construction* (pub. Prentice-Hall, ISBN 0-13-629049-3). This book, I feel I can state with little danger of effective contradiction, contains the most lucid description of object-oriented techniques that you will find; whatever their opinion of the Eiffel language, few of Meyer's opponents will deny that he can write like an angel.

The book has acted as a superb advertisement for Eiffel. Interest in the language has spread from the academic world, and is now beginning to appear in the commercial mainstream. At the same time, control of Eiffel has been passed from Meyer's company Interactive Software Engineering to a non-profit consortium, and alternative (non-ISE) implementations of the language have begun to appear, notably SIG's implementation for DOS. Eiffel is fast becoming a practical possibility for ordinary projects.

Eiffel is different. It is not just another Algol variant with a few bolted-on object extensions. Programmers who track current thinking should at least to know about the ideas in Eiffel; this interview may serve as a taster for further reading. ***WRW.***

Santa Barbara

I had this dual career for about eight or nine years. In 1983, I decided to develop the academic side of me a little further, so I took what I thought would be a year's sabbatical at the University of California Santa Barbara (in the end I stayed four years). There I taught much of the basic software curriculum.

Now, in the data structures and algorithms course that I taught it was the department policy that the professor should use C. This was strange, because most of the other courses enjoyed a lot of academic freedom. But C was a particular requirement because they were using this course for two purposes: 1) the official one - to teach data structures and algorithms - and 2) to serve as a filter to separate the men from the boys.

You're saying the course was made deliberately difficult?

Oh yes. Deliberately puzzling. I hated it. I should say that I didn't know C very well at the time, so I had to learn it - and it was horrible. I wanted to teach data structures, algorithms, and systematic approaches to programming problems. Instead of that, I found myself trying to help students debug programs using pointers, finding incorrect memory references and so on. I decided that I could never do that again.

So in '85 I started Interactive Software Engineering with a few colleagues in order to follow up certain aspects of our research. The work in the company soon became more interesting, from a purely scientific viewpoint, than the work we were doing in the University, because I could use whatever I found scientifically valuable as opposed to bowing to the student pressures to use C.

When did Eiffel appear?

When we started the company we really wanted to develop some CASE tools - in particular a structural editor, now the Archi-Text product. But I also wanted to use proper techniques - I didn't want to be too far from what I was trying to teach. So we looked around for a decent object-oriented environment and we just couldn't find one. Smalltalk was attractive, but it was too far from the mainstream. C++ was available (as was Objective C) but we really didn't discuss it. It was not up to our standards.

I very quickly wrote a specification for a modern version of Simula, with some simplifications and some extensions. I also a wrote a basic version of the libraries. Libraries are the key to the success of object-oriented technology in Eiffel. If it can be defined by just one sentence, Eiffel is a language to write the Eiffel libraries - that is to say to write the best possible, reusable industrial-quality software components that we could think of.

I did that in just a week or so, and that was it. At first, we didn't really think about it as being a tool for others. It was only months later that we realised that we had something that no-one else really had: a complete, statically-typed, efficiently implemented language that could actually provide an object-oriented solution to mainstream industry. It's only then that we started thinking about marketing the product.

How was Eiffel first implemented? Was it one of those languages which was always implemented in itself?

No. We didn't have a bootstrap strategy initially, which may have been a mistake. We just used the obvious solution, that is to say to write it in C. And I should say we were sorry for that decision for a long time. It is only in Version 3 that we have managed to write the entire system in Eiffel. With our portability requirements, C was the almost inevitable choice.

What's in a name?

Why is it called 'Eiffel'?

The question should be, 'How could it be called anything else?' It was almost inevitable. First there's this habit of naming languages after people: Pascal, Turing and many others. We decided, for once, to take not a scientist but an engineer, and a really great engineer. Second reason: the method promotes bottom-up software construction. If you think of the shape of the Eiffel Tower, and you try to build it top-down... Third, and probably the important: if you look at that structure, it's an extremely elegant, powerful, reusable, extensible structure. However it is built of a few small, simple parts which you combine, which is exactly the same idea as object-oriented software construction.

The opposition

How would you characterise the difference between Eiffel and C++?

There is a difference in philosophy and there are technical differences. The difference in philosophy comes from a different view of what 'compatibility' means. I don't think there is any disagreement with respect to the necessity of reusing existing software, particularly C software. The divergence resides in how it should be done.

The C++ (or Objective C, or Turbo Pascal) approach is that you should have compatibility at the language level. So you take C and you add things to it. The Eiffel view is that compatibility with existing software is not an excuse for polluting the language. The language can be C, which is a certain technology, or it can be object-oriented, which is completely different.

You don't make a device that is both a diode and a transistor. If you have an existing machine that uses diodes then, fine - you want to keep it. You could put in wires to the transistors and have communication links and so on, but you don't try to transform a diode into a transistor incrementally. This is the Eiffel position. You choose between the Eiffel, object-oriented world and the C world, but you should keep the two separate; because otherwise you risk losing on both counts.

You lose the simplicity of C: you lose the ability to implement it efficiently, the ease of writing it and the ease of teaching the language, which are the three major advantages of C. On the object-oriented side, you again lose a lot. You lose simplicity - because the object-oriented paradigm has to be combined with totally incompatible concepts. You lose the ease of teaching the object-oriented paradigm. And you lose some of the most important advantages of object-orientedness. For example, it is quite impossible to have garbage collection in C. You lose typing - you cannot have both the C type system and an object-oriented type system. You lose the ability to do things like exception handling properly, as you must take into account all kinds of bizarre side-effects.

So you actually lose the most important benefits, the real breakthroughs, the quantum leaps that you can get from object-oriented technology, and all because of this stupid requirement of remaining compatible with something that has nothing to do with object-oriented technology. The technology is too good, too important, too potentially beneficial to damage it because of concerns that may appear valid in 1986, or 1989, or 1992, but will totally disappear from the scene if the technology becomes successful.

As for technical differences, there's a whole list. Type-checking; assertions; genericity (particularly constrained genericity, which is the only way to get safe genericity); exception handling (which has been proposed for C++, but Eiffel has them now),

SOFTWARE DEVELOPMENT 92

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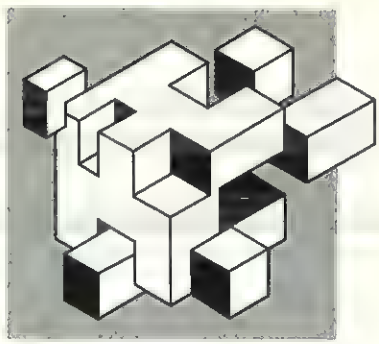

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TUESDAY 16TH JUNE

OPEN PLENARY – setting the scene

THE INSTITUTE OF SOFTWARE ENGINEERING

09.30 The ever increasing importance and scope of CASE. Paul Madden, Research & Consultancy Manager, The Institute of Software Engineering.

10.00 CASE integration - more than having a repository. Ken Thompson, Research and Consultancy Manager, The Institute of Software Engineering.

10.30 Reverse engineering - is it worth it? Alan Frazer, Consultant, The Institute of Software Engineering.

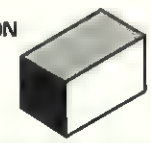
11.00 Coffee

11.30 Object orientation – not just for the programmers. Dr George Wilkie, Consultant, The Institute of Software Engineering.

12.00 Application generators - fact or fiction? Dr Patrick McParland, Consultant, The Institute of Software Engineering.

12.30 Group discussion

13.00 LUNCH AND EXHIBITION VISIT



TRACK 1

DATABASE ARCHITECTURES & PROGRAMMING.
Chairman – Richard Attenborough, Editor, ProgramNOW.

14.00 Testing 4 GLs - a comparison. Christine Seager, Systems Analyst, Loud and Bow.

14.45 User requirements have led to OODBM's. Mark Ellis, Technical Support Manager, Sema Software Technology.

15.30 Tea

16.00 Things in my notebook .... an object oriented database for small computers. Steve Swallow, Quality Assurance, System Applied Technology.

16.45 Multimedia design for databases. Sebastian Karl, Sales Manager, Continuous Technology.

17.30 Close

TRACK 2

UNIX
Chairman - Mr Zdravko Podolski, Project Manager, UK Unix Users' Group and Insignia Solutions.

14.00 The future of Unix. Chris Stott, Kernel Engineering Manager, The Santa Cruz Operation.

14.45 Unix as the future. Graham Taylor, Chairman UK Marketing Group, Unix International.

15.30 Tea

16.00 What is SVR4? Nick Price, Technical Director Europe, Unix International.

16.45 NeXtStep and UNIX. Gregor Bailar, Managing Director, NeXt Technology.

17.30 Close

WEDNESDAY 17TH JUNE

TRACK 1

NETWORKS ARCHITECTURE & OPERATING SYSTEMS
Chairman - Richard Attenborough, Editor, ProgramNOW.

08.30 Distributed Computing: Models technology for real-world solutions. Richard Morley, Consultant Analyst, Systems Support Associates.

09.15 Enterprise-wide client/server computing. Neil Morgan, Desktop Product Marketing Manager, Oracle.

10.00 Coffee

10.30 XBase - the issues. Speaker to be confirmed.

11.15 SQL on power - PC networks. Adrian Lea, Freelance Analyst.

12.00 LUNCH AND EXHIBITION VISIT

EXPERT SYSTEMS
Chairman - Nick Evans, British Computer Society Specialist Group on Expert Systems.

14.00 GUI building & AI - an alternative approach. Richard Barker, Development Manager, Scientia.

14.45 Generic algorithms in CASE. Alistair Blair, Development Manager, ITACS.

15.30 Tea

16.00 Intelligent Systems. Matthew Colbourne, Business Manager, Advanced Technologies Group, SD-Scicon Consultancy.

16.45 Distributed agents in parallel data fusion. William Pickles and David Catton, Directors, Strand Software Technologies.

17.30 Close

TRACK 2

OOPS DESIGN
Chairman - Chris Stone, President, Object Management Group, USA.

08.30 Object oriented method - adoption and selection. Alec Bruty, Director, Axon Seminars and Training.

09.15 Adopting an object oriented approach. Nicholas Wybolt, Director of Engineering, Cadre Technologies.

10.00 Coffee

10.30 The object design challenge. John Daniels, Director, Object Designers.

11.15 Object oriented databases. Mary Loomis, Vice President, Versant Object Technology, USA.

12.00 LUNCH AND EXHIBITION VISIT

OOPS PROGRAMMING
Chairman - Chris Stone, President, Object Management Group.

14.00 Options in object oriented development. Steve Baker, Object Business Manager, QA Training.

14.45 OOPS design metrication. Dr Trevor Hopkins, Senior Lecturer, Department of Science, Manchester University.

15.30 Tea

16.00 The silver anniversary of the silver bullet. John Salt, Simulation Software Engineer, Eurotunnel.

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16.45 Investing for the future with object oriented Clipper. Alan Davies,Technical Manager, and Roy Corneloues, Technical Marketing, Nantucket.

17.30 Close

THURSDAY 18TH JUNE

TRACK 1

THE HUMAN COMPUTER INTERFACE

Chairman - Miles Macleod, Senior Scientific Officer, HCI Group, National Physical Laboratory.

08.30 Migration to graphical user interfaces in the 90s. Mark Rogers, Managing Director, MF Systems.

09.15 HCI and CASE. Phil Sully, Consultant Manager, CGI-LS3.

10.00 Coffee

10.30 Task oriented graphical systems. Paul Seaton, Consultant, System Concepts.

11.15 The PC of the 1990s: the move toward computer supported collaboration. Ian Wilson, UK Technical Marketing Manager, Intel Corporation.

12.00 LUNCH AND EXHIBITION VISIT

C++

Chairman - Mike Banahan, Chairman, European C++ User Group.

14.00 Experiences of migration from C to C++. Kerry Williams, Software Specialist, Swiss Bank Corporation.

14.45 Selecting class libraries. Dave Mansell, Managing Director, Citadel Software.

15.30 Tea

16.00 Lessons learned on C++ projects. Keith Laidlaw, Database Specialist, British Airways.

16.45 Practical experience of C++ using prototyping. Kevin Large, Principal Consultant, Hoskyns Group.

17.30 Close

TRACK 2

AM: WINDOWS DESIGN AND ANALYSIS

PM: WINDOWS PROGRAMMING

Chairman - Steve Baker, QA Training.

QA Training provide technical training, consultancy and development tools in most programming technology areas. QA have been working with Windows for many years and are Microsoft's Systems Partners.

Steve Baker is a well known speaker, having written on development issues and is currently a technical adviser to the Windows Development Association.

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16 June PM	Database architectures & programming ☐	UNIX ☐
17 June AM	Networks architecture and operating systems ☐	OOPS design ☐
17 June PM	Expert systems ☐	OOPS programming ☐
18 June AM	Human computer interface ☐	Windows – design and analysis ☐
18 June PM	C++ ☐	Windows – programming ☐

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AD/EXE

the assignment attempt (the ability to force a type on a variable) which is absolutely essential; and there are the persistence facilities. Going a little bit beyond the language, the presence of standard libraries is, I think, a really strong plus for the Eiffel approach. In C++ there are all kinds of competing libraries but nothing has emerged as a real standard, in part because the language does not support the tools (such as genericity) for building libraries.

Template faults

With regard to genericity, what is wrong with templates as implemented in C++?

To start off with, templates are only now getting into the language. But they are only an emulation of genericity. In particular they are not closely connected to the type system, and there is no support for constrained genericity. It is very important to be able to accept actual generic parameters only if they are descendants of a certain class. For example: I want to have vectors of something of type `T`, and I want to be able to add two vectors, so objects of type `T` must have the + operation applicable to them. It means you can then have a vector of integers, but you cannot have a vector of nuclear submarines if a nuclear submarine doesn't have a + operation.

Templates cannot support this because they are just a kind of macro. I see templates as making more official what people had been doing manually in C++ so far, which is using the pre-processor to generate variations of a class.

But templates do give you some type protection... You're saying that's not enough?

Yes, I am. Type protection in C++ is in any case always problematical. As long as you can have those casts, as long as you can convert from any pointer type to any other pointer type, what type we talk about becomes pretty meaningless.

In a recent interview with .EXE, Bjarne Stroustrup said that he didn't think that it was necessary to add Eiffel-style support for assertions to C++. He thought it sufficient that one could acquire add-on specialist tools to do the job, and that he did not believe in cramming too many features into a language. Is that not a fair comment: if you need assertions, you should buy a separate tool?

The comment 'I don't believe in cramming too many features into a language' is a fair comment. I would say that about C++. I don't think it is proper to have, for example, function pointers and dynamic binding in the same language, because it is confusing. If you don't believe in crowding too many features into a language, then you wouldn't produce C++, because C++ is exactly that. It's taking C, which already had its share of language features, and adding more, including some which are redundant and incompatible.

This business of function pointers is typical. If you use an object-oriented language like Smalltalk or Eiffel, then to obtain automatic selection from various operations at run-time you use dynamic binding. If you use C, you can emulate this in a rather unpleasant low-level fashion by having arrays (or other data structures) of function pointers. Now this is another way of doing things; it's less nice, but it works. What I don't think is proper is the C++ approach in which you have both mechanisms. Programmers have to choose all the time between the one way of doing things and the other, which means a lot of confusion and complexity.

I decided that I should learn up about C++ after all, so I went and read the Ellis and Stroustrup book *(C++ Annotated Reference Manual)* from cover to cover. I was horrified to see how many criticisms there are in that book of C and C++. There are comments like, 'the array facility of C, and hence of C++, is brain-damaged.' You read this and you say, 'What? You're designing the language, and now your telling us that something is still wrong?'

There are comments like this on many other aspects. There are comments like, 'This is available, but don't use it.' I don't think that is good language design. If you produce a language design book, you should be proud of it and there shouldn't be any dark corners. I think I can say that about Eiffel. I'm not saying that Eiffel is perfect, but I cannot point to any construct in Eiffel for which there is a comment of the form 'Don't use it'.

Returning to your question: I don't think that assertions should be separate from the language. Assertions are absolutely essential to object-oriented design. This was something which was mentioned in *Object-oriented Software Construction*, but clearly

A Few Eiffel Terms

Assertions - C programmers will be familiar with the macros in ASSERT.H, which allow the programmer to assert that a condition is true. If it is not, the program aborts with an error message. An example use is to protect a routine that calculates square roots of positive reals from being called with a negative parameter.

Although Eiffel's assertions are superficially similar, they are fully integrated into the language (for example, they have their own set of inheritance rules) and are much more powerful. There are various kinds. *Preconditions* work like the square root example above: 'before you call this routine, *this* condition must be true.' *Postconditions* say what must have happened on the completion of a routine. A simple example is a routine which adds an item to a list; its postcondition might state (among other things) that the list is non-empty on return. *Invariants* are attached to classes rather than routines; these make statements about a class's data that are always true. For example, if the list class has a Boolean field `empty` and an integer field `count_of_items`, then a reasonable invariant is `empty = (count_of_items = 0)`.

As well as their debugging use, assertions are used in documentation of classes, and to enforce 'Design by Contract'.

Assignment attempt - this is Eiffel's mechanism for identifying object types at run-time. Using a special assignment symbol `?=`, the programmer is allowed to attempt to assign to an known object from one of unknown type (perhaps unknown because it has just been loaded from a database). If the type system prohibits the assignment, the target object becomes void; if it is allowable, a normal assignment takes place. This system fulfils the same purpose as Turbo Pascal's `TypeOf` function and C++'s proposed `ptr_cast()` and `ref_cast()` 'safe cast' extensions.

Genericity - Generic classes are 'typeless' container classes which are assigned a type when instantiated. For example, one could build an all-purpose `list` type, then use it to create a list of numbers, a list of windows, a list of addresses. Please see Meyer's comments in the text for an explanation of *constrained genericity.*

Type-checking - Eiffel is a very strongly typed language. In particular, *all* type-casting (which Meyer describes as 'a sordid back-alley deal') is forbidden.

not enough. I've written more about it since then. It's this whole idea of Design By Contract. That, for me, gave the theory behind object-oriented software construction. It's not just that you have classes and inheritance and so on; it's that you build software in such a way that it's made of pieces that communicate with each other on a basis of well-defined obligations and benefits.

I have tried to explain Design by Contract in a chapter with that title, part of a collective book that has just appeared, *Advances in Object-Oriented Software Engineering*. It's this idea that software is a combination of various pieces which communicate with each other not on the basis of pre-defined assumptions, but on the basis of proper and precise definitions of what each one of them expects from the other and must provide. This is what justifies the idea of preconditions, postconditions and invariants, and I don't know how to teach object-oriented programming without them. When I teach object-oriented techniques, I spend anywhere between one third and one half of the presentation on assertions - especially in connection with inheritance. I don't think anyone can understand inheritance properly without introducing assertions.

I also don't think you can understand the notion of class without the idea of the invariant, which expresses the integrity constraints on a certain data type independently of how the data type is implemented. This is where I disagree with Bjarne Stroustrup. I don't think assertions are 'fairly useful'.

Be assertive

Do you think people who use Eiffel always use the assertion mechanism?

People who use Eiffel well use them a lot. Even people who don't include assertions in their own software, because they haven't yet understood the power of this notion, benefit from them anyway.

The practice of software development in Eiffel is pretty much based on libraries. When you switch to Eiffel, you don't necessarily see as the major change a change in language or in method; what you see is a way to start working at a higher level of abstraction by using libraries. Now, these basic libraries are fully loaded with assertions. The documentation is essentially based on assertions, and their use is based mainly on assertions too. So even if somebody is only starting to work with Eiffel, and has is not yet putting assertions in his own software, he is going to benefit from them anyway.

It is true, however, as you implicitly suggested, that some people who start with Eiffel - especially if they come from something else, like C++ - don't necessarily put assertions to their full use. But they usually start using them after some experience.

Another point about assertions: when reading your book** Object-Oriented Software Construction **I found that it was not always obvious to me, as a programmer rather than a mathematician, why particular assertions were applied - particularly in the case of the invariant. Is it just that I am not smart enough, or have you found this to be a more general difficulty?

In my experience, and the experience of people working with me - both developers in our company and users - it is true that you don't necessarily get the invariant right first time. As you start improving a class, adding things to it, and understanding it better, this process is pretty much embodied in writing the invariant and improving the invariant. The more you understand what a class is

about, the more you are able to express invariant clauses and; when you add a clause to your invariant, then you gain something in understanding what the class is about.

This doesn't necessarily come right the first time - but proper software design doesn't come right first time anyway. The process of improving the software and the process of writing and improving the invariant go together. It's not surprising that these things should appear a little difficult at first - software design *is* difficult. But invariants, and assertions in general, enable you to get to the heart of the matter.

Garbage

Can we talk about memory management. Why do you use garbage collection, instead of 'manual' heap managing systems?

In the manual for Eiffel-S, which is the SIG implementation for DOS, they have a very nice analogy. They say something like: 'An object-oriented program without a garbage collector is like a pressure cooker without a valve. You don't know exactly when it is going to happen, but you know that sooner or later it is going to explode'.

An object-oriented program generally creates a lot of objects. A lot of them are going to become unreachable. You can of course make sure that not too much of that happens - having a garbage collector is not an excuse for generating tons and tons of garbage, you still have to be careful - but if you start managing these things yourself it's dangerous and it's tedious.

It's dangerous because you always run the risk of 'freeing' (in the sense of C's `free()`) an object which in fact is still needed. This is the source of some of the worst bugs that exist in C programming. It's a very serious problem, because the consequence of the error is usually quite remote from the source of the error. Usually when you think you can free an object and you are wrong - there is still some reference pointing to it - you use that reference much later in the program, so that tracing back the cause of the error may be extremely difficult.

As for the tedious part: if you do your storage management manually, you end up polluting your code. If you want to do manual reclamation, you have to write a lot of recursive `free` procedures. As long as you have the kind of complicated data structures that are possible in object-oriented programming, it's not enough to free one object; you have to follow the pointers. You end up being the garbage collector yourself. Programmers have better things to do with their time.

The Ellis and Stroustrup book is the most damaging criticism of C++ that I know

It seems to me that if you don't have a garbage collector, you lose many of the major benefits of object-orientation. Personally I wouldn't write an object-oriented program in an environment in which I didn't have a garbage collector.

C programmers are hostile to garbage collectors because of the time overhead...

That's just because they don't know about modern garbage collection technology. In version 3 of our implementation, we estimate that the overhead of garbage collection - the difference between running a program without garbage collection or running it with garbage collection - is about 20%. But this is not the real overhead, because if you didn't have the garbage collector, you would have some overhead due to manual reclamation anyway. With version 3 - version 2.3 was not as good in this respect - we do not expect anybody to run an Eiffel program without garbage collection enabled. But you can still switch it off if you want.

On the street

How many implementations of Eiffel are there at the moment?

Among the ones I know about are: there's of course ours - Interactive Software Engineering's implementation of Eiffel; there's an implementation by SIG Computers of Germany, which is essentially a DOS and OS/2 implementation, although there's also a UNIX version of it; there's a company in the US called Power Solutions that is about to release its implementation; and there's a GNU version that is in the making but is not released yet. Oh, and I hear that there's some people called Nexnix Ltd in Brighton who are developing a compiler.

By the way, the ISE implementation will support DOS/Windows some time later this year.

What are the main features of version 3 of the Eiffel language and environment?

Probably the most important thing is this 'melting ice' idea, which is an attempt to get the best of both the interpreted world and the compiled world. If you look at why some people use environments such as LISP systems and Smalltalk systems, once you have removed the superfluous arguments, it boils down to just one, practical, serious idea. With an incremental environment such as Smalltalk - I want to say 'interpretative environment' but that's not quite accurate - you can get a very quick turn-around.

Until now, with statically typed, compiled, object-oriented languages you have had to go through a fairly classical edit-compile-link-execute cycle. This means in a big system, even for a small change, there's a fairly long wait. This is an issue we have been grappling with for a long time, because there is absolutely no philosophical reason why you should have to choose between a quick turn-around and static typing.

Static typing is good. It gives you safety, because you are able to catch errors much earlier, and it gives you efficiency, because it make it possible to generate much, much better code. And there's no reason why these goals should be incompatible with a very, very quick turn-around.

This is essentially what this melting-ice technology of Version 3 achieves. You can have extremely quick re-execution after a change, even though you retain the static typing. The idea is very simple. Whatever you change inside the normal development cycle is going to be interpreted, so that it's extremely fast to see the results of a change after you have made it. The interpreter doesn't have any significant negative effect on performance, because typically you're dealing with a big system and after a change only a small part of it will have been affected, so most of it will still be compiled. We think that this is a major advantage that will make all the difference in the world.

Another aspect to version 3 is the presence of the library called EiffelVision. This is a graphical user-interface library supporting various tool kits - to start with Open Look and Motif - with complete source code compatibility. So people can write the best

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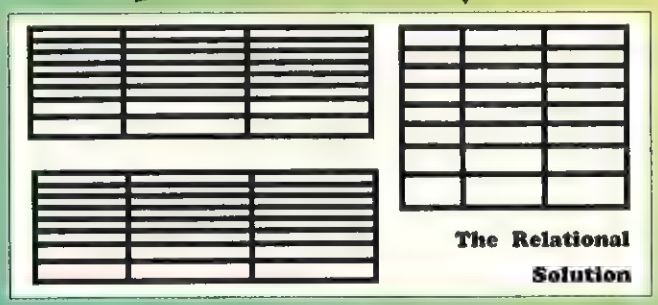

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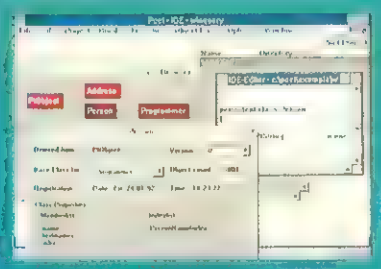

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into user interface applications in terms of high-level concepts like menus, windows and so on, without being concerned with the details of Motif etc. Then they can just port their application to various graphical platforms without making source changes. Eventually this will also apply to Windows and Presentation Manager.

Also important in version 3 is the availability of the standardised relational database interface. This follows the same principles as our GUI library; that is to say you program in terms of the SQL model and then you go to some other RDBMS without source code changes. This is very important for big projects in commercial areas. Most big relational systems currently use C, so it is very important to be able to access traditional data quite easily and to map objects onto relational data.

Looking forward

A recent .EXE Survey showed that about half our readers used C or C++ as their primary development language, about 10% use Pascal, and no other single language collected more than about 5%. There were no Eiffel users. What is your prediction for the result of next year's survey?

Let me consider two years from now, when Eiffel will have had a chance to make an impact on the DOS world. I think that people coming from languages like Pascal and Modula-2 will very naturally migrate to Eiffel. They'll find themselves on safe ground with strong typing, general software engineering concerns and so on. I would see them migrating *en masse* to Eiffel.

I think a proportion of people programming in C will migrate to Eiffel as well. Those are the people who, again, have serious software engineering concerns, and want to be able to guarantee the quality of the code they produce. I don't know how much that is - it's a certain proportion of people writing in C today.

As for people using C++ today; they're still to a large extent the *avant garde*, the early pioneers. I would say that once these people have understood the benefits of object orientation and the limitations of C++, they will look for something more serious. I don't think there is much competition to Eiffel.

So without making any too wild predictions, I think that, if you repeat your survey two years from now, from 15% to 25% will be using Eiffel.

And C++?

I think that five years from now, no-one will be using C++.

This despite the fact that 80% of our C users are looking at C++?

That's all they have heard about. To a certain extent you cannot expect anything else. Suppose somebody has been raised to the Stalinist creed, who has only ever read political literature favouring Marxism and Leninsm. If you ask him, 'What is the next thing?', he's not going to answer 'Democracy and the free market.'

EXE

Many thanks to Dr Meyer for taking the time to give this interview. To find out more about Eiffel, you should contact Caroline Browne at Applied Logic Distribution (081 780 2324).

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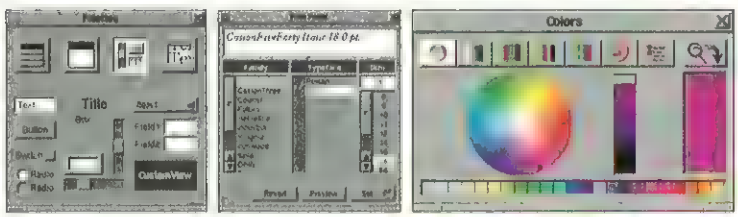

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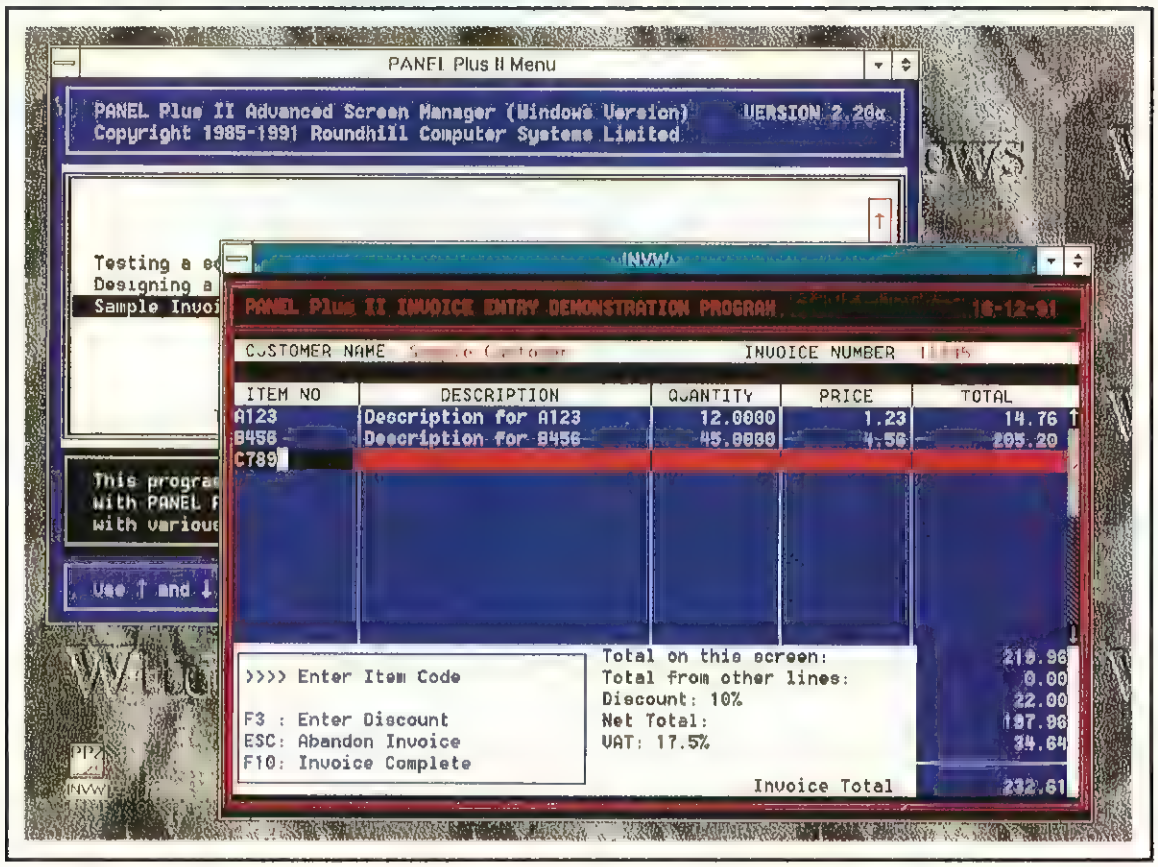

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CIRCLE NO. 925

New Improved Lint

The C language has so many pitfalls for the unwary that it is a wonder programs ever work. As Dave Stiles discovers, Gimpel Software's Lint is a major aid to ensuring they do.

C Compilers are not too hot on reporting the more subtle programming mistakes. They are usually quite happy to accept a reference to an uninitialised variable or an assignment of an over-large constant; and if a `switch case` is allowed to flow into the next one, fine.

This is reasonable behaviour for a compiler. It has enough trouble looking for real errors, without checking programming logic. Hence the existence of Lint.

Lint? It picks up all the fluff from your source code, leaving a nice, clean program. It gives a much more in-depth analysis than a compiler ever could. It proceeds through one or more source files, in one pass, and tells you what is wrong with the code.

Lint also reports potential portability problems and pin-points non-ANSI and other suspicious coding practices. It ends by generating a wrap-up report which details unused declarations, definitions and header inclusions, undeclared variables and functions and so on. When several files are processed, a global wrap-up is generated. This shows functions, variables etc which are unused in the files and indicates global variables and functions which could be local to a single module.

Open the Box

Gimpel Software's PC-Lint V5.0 (Lint V5) is supplied in the usual form of three-ring binder, shrink-wrapped manual and disk package. Both disk formats are included: 720 KB and 1.2 MB. It operates on any PC, XT, AT or PS/2 compatible under MS-DOS 2.0 or later. It also works under Windows and in an OS/2 DOS box. (Gimpel also markets a generic lint, under the title FlexeLint, for use on all other platforms.)

Lint V5 assumes your C source code is to K&R and ANSI standards; where there is conflict, ANSI overrides K&R. As it was completed after the ANSI Committee closed up shop, it should meet the standard.

The 300 page manual is reasonably well laid out and easy to use. It includes sections on installation and configuration, special features and language extensions, and preprocessor handling. A major section is devoted to *strong types*, a new feature introduced by Gimpel.

The largest section is devoted to the messages; I estimate there are about 400, of which 80 are new to V5. There are four types of consumer messages (errors, warnings, information and elective notes) and two varieties of run-time errors. Messages are explained in full, usually with an indication of what to do about them.

One section gives differences between V4 and V5; I wish all manuals did this. For those upgrading, this is probably the first section to read. A section for newcomers is Living with Lint: a quick guide to overcoming bad programming habits without too many tears.

I opened the disk package with trepidation, as it claimed to be for 386 processors. Mine is a 286, and I'd been had before. I put the disk in, typed A:INSTALL... and watched the computer die.

Lint V5 includes the Phar Lap DOS extender. This does not normally crash a machine, even if it cannot run. The Install program was not Phar Lap's (nor was it Gimpel's), and it made a mistake. It assumed that expanded memory was to a recent EMS standard. My machine, a rather old AT clone, has no address line 20 and only a primitive EMS Version 3.0. So, legs in the air.

```
//    Compiler Options for Microsoft C Version 6.0 and earlier
-cmsc
      This file contains options to allow PC-lint to process source
/     files for your compiler.  It is used as follows:
'
 /    lint  co-msc.lnt  source-file(s)

        // If you're programming MS Windows set the option
        .    +e934 to report passing short auto pointers as arguments
        // See Petzold, Windows 3.0, pp 897-902
           You might also want to set the option: -printf(w2,wsprintf)
        // It makes wsprintf like sprintf except that pointers have
        // to be far.
-format=%(%f(%l)\s:\s%)%t\s%n: .s%m
        // error format expected by Microsoft editor
        // Note that %c can also be used to specify column
-e46    // allows bit-fields to be other than int or unsigned
        // If you are use Microsoft Editor try using -hfa 3
        // the 'f' tags most messages with a location.
        // To tag ALL messages with a location use -hF...
-elib(514)  // allow #if <boolean> | <boolean>
+fan    // allow anonymous unions
+fdi    // Use directory of the including file
+fcd    // makes cdecl significant -- needed for MSC option -Gr
-esym(123,min,max)  // allows users to use as variables
 d_MSC_VER=600  // The version number of Microsoft C (alter if necessary)

          // while processing compiler (library) header files ...
-elib(652)  // suppress message about #define of earlier declared symbols
 elib(762)  // suppress message about multiple identical declarations and
-elib(760)  // suppress message about multiple identical macro defs

/,  The following functions exhibit variable return modes.
//  That is, they may equally-usefully be called for a value
//  as called just for their effects.  Accordingly we inhibit
/   Warning 534 for these functions.
/,  Feel free to add to or subtract from this list.

-esym(534,close,creat,fclose,fflush,_flsbuf,fprintf,fputc)
-esym(534,fputs,fscanf,fseek,fwrite,lseek,memcpy,memmove,memset)
-esym(534,printf,puts,scanf,sprintf,sscanf,strcat,strcpy)
 esym(534,strncat,strncpy,unlink,write)
```

Figure 1 - Compiler Options Script for Microsoft C

PC-Lint itself, when finally installed, was less brutal: it merely told me it could not run without a 386 and left the machine running.

I transferred to a bare bones AT which had no extra memory, and Lint installed with no problems. The session consisted of simple questions, with options to install for a primary compiler and as many others as I wished. As with all polite programs, it asked for the target drive and directory.

Two variations of Lint V5 are supplied: LINT.EXE, compiled for a 386 processor and using the Phar Lap extender; and a bound DOS-OS/2 version L.EXE. The distribution disk includes two utilities to aid in setting up the Phar Lap extender. Total installation size is about 550 KB; if you remove the unused version, this drops by 200 KB or 350 KB.

The installation includes a mere handful of short example files. I guess the idea is that your own code will provide hours more amusement and education than any example code ever could.

Configuration

Since I selected a Microsoft compiler, the installation program installed compiler definitions file CO-MSC.LNT (Figure 1). Lint V5 comes with 28 preset compiler definitions, from the common to the obscure. Among the latter are Intel 8051 and 8196/8198 compilers. If your compiler is not included, the generic file CO.LNT can be tailored to suit.

Gimpel also supply a generic library header, SL.C, which you can tailor if your compiler does not include function prototypes. Five preset headers are also supplied.

Lint is normally run from a batch file, to simplify control of command line switches. Output is directed to a file. This, believe me, is necessary; there can be an awful lot of messages. I send my output to RAM disk and include a line in the batch file to load the error file into an editor.

Lint's command line comprises a mix of option switches and file names. Anything without a switch prefix character (+,-) is assumed to be a file name. If the name has no extension, PC-Lint looks for a matching file with an extension of .LNT, .C or .H before giving up. Wildcards are acceptable: LIN *.C goes through all the .C files in the current directory.

The command line option `-iC:\LINT` tells PC-Lint to look for .LNT files in directory C:\LINT; similar to the DOS APPEND command.

You can specify any number of .LNT control files or .C source files on the command line or in control files. The original installed system specifies only a single control file, STD.LNT. This contains a reference to OPTIONS.LNT and to the compiler definition file (eg CO-MSC.LNT).

OPTIONS.LNT contains parameters which you decide are best for your way of working. Where these vary between projects, place a copy of the file in your working directory. A typical reason for this would be to include various compile-time switches and macros; eg `-DDEBUG_ON`. If this is not done, code defined inside a `#if` clause will be ignored by lint.

Besides placing lint options inside .LNT files and on the command line, they can also be included directly in source files. If the word *lint* follows an opening comment, the text following it is processed by lint. For example `/*lint -esym(715, mgn, mgs)*/` instructs lint to ignore warning 715 when it applies to variables mgn and mgs.

Any warning, error or information message can be turned on or off globally, or suspended locally and then reinstated. This can be carried out with `esym` for named items only, or for all items (eg -e715). Where necessary, whole groups can be cancelled (eg -e7??). However, this is obviously counter-productive if taken to excess.

The First Test

I passed a module from my latest program, validated under Lint V4 with a few option overrides, through V5. I specified only the default options, to see what would happen. Lint threw up 12 errors and 15 warnings. Of these, nine errors were due to signed/unsigned mixes in constant strings, of which I was already aware.

Another error concerned a mix-up over an `int` pointer; an unsigned pointer went into a function which wanted a signed one. The variable was only used as a boolean flag, so it did not actually matter. However, I will now reconsider my policy of turning off signed/unsigned pointer checking.

The other errors involved a re-declaration of functions between the header, where they were declared as `int _cdecl myfun(void)` and the source file, which had `int myfun(void)`. I declared these prototypes under Lint V3. V4 accepted them. However, V5 option `+fcd`, in CO-MSC.LNT, specifies that `_cdecl` is significant. Since the function definitions in the source code did not include `_cdecl`, Lint complained.

The warnings generated on my code all complained of an inconsistent return mode from called functions. A return from a C function can be used or ignored. In many cases, eg `strcpy()`, it does not matter; however, functions such as `atoi()` would be useless if the returned value were ignored.

PC-Lint allows you to specify functions as having an ambiguous return mode. This is

```
enum { PAG_ASSLST, PAG_PERLSTR };
int fldid;

  switch(prvpag)
    {
    case PAG_ASSLST  : fldid=QFP_CNAME; break;
    case PAG_PERLSTR : fldid=QFN_RECID; break;
    }
  load_name(fldid);

Lint comment:
     load_name(fldid);
edt.c(161) : Warning 644: fldid (line 154) may not have been initialized
```

Figure 2 - Possibly Uninitialised Variable

```
#define F12 (unsigned int)(134<<8)

Lint comment:
    case F12 : do_f12(); break;
edt.c(509) : Warning 648: Overflow in computing constant for operation:
             'shift left'

Repair:
#define F12 (unsigned int)((unsigned int)134<<8)
```

Figure 3 - Constant Overflow

```
    case K_QUIT : exit(0); break; /* exit() unrecognised as end by Lint */
edt.c(1255) : Warning 527: Unreachable
```

Figure 4 - Exit as End of Switch Case

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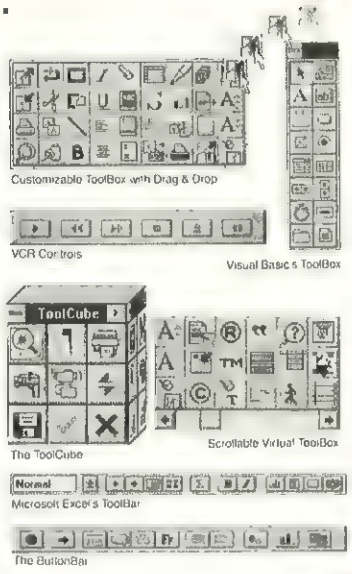

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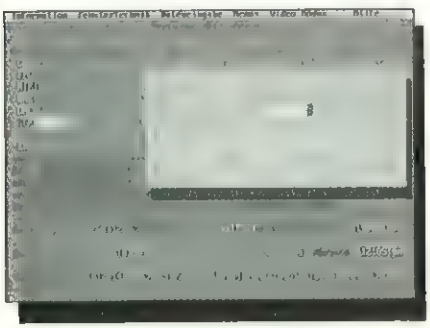

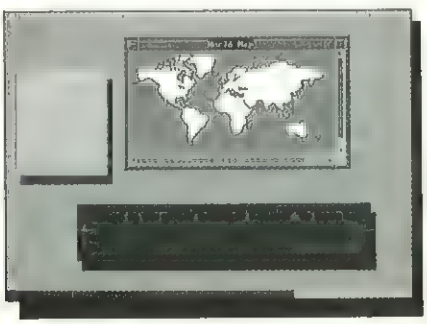

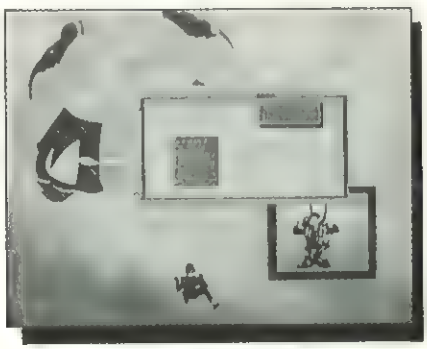

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preset for a couple of dozen standard functions; `eg -esym(534, strcat, strcpy)`. I normally turn off all return mode checking with `-e534`; Perhaps I should review this practice.

The final difference in the comparison was in the wrap-up. It showed that an included header file was not actually needed. Lint V4 had an occasional blind spot on header inclusion. Although not causing any problems, loading headers obviously takes time and space, so removing unnecessary ones speeds up both linting and compiling.

After transferring my Lint V4 options to V5, I obtained almost the same behaviour from V5 as from V4. Almost. The `_cdecl` errors and extraneous header warning remained. After checking one module, I linted the complete set. The result was initially alarming, but I calmed down as I checked the messages, three of which were more unused include files. However, most problems came from a new warning: 644, 'Variable may not have been initialised'.

```
enum EFLG { BAD=-1, ZERO, GOOD, STOP };
typedef int BOOL;
#define TRUE  (BOOL) 1
#define FALSE (BOOL) 0

BOOL go=TRUE;
enum EFLG efl=ZERO;
int num;

  ....
  go=num;
  if(go) efl=5; else efl=1;

Lint comments:
  go=num;
tst.c(110) : Warning 632: Assignment to strong type (BOOL) in context:
             assignment

  if(go) efl=5; else efl=1;
tst.c(111) : Error 64: Type mismatch (assignment) (int/enum)
tst.c(111) : Error 64: Type mismatch (assignment) (int/enum)
```

Figure 5 - Strong Type Checking

```
/*lint -strong(AJX,FLAGS)*/
/*lint -strong(AiJX,FLAGS1)*/
/*lint -strong(AiJX,FLAGS2)*/

typedef unsigned FLAGS;
typedef FLAGS FLAGS1;
typedef FLAGS FLAGS2;

void xx(void)
{
FLAGS flg;
FLAGS1 flg1=128;
FLAGS2 flg2=256;

  flg=flg1;
  flg2=flg;
  flg1=flg2;
}

Lint comment:
  flg1 flg2;
f:x.c(17) : Warning 632: Assignment to
strong type (FLAGS1) in context:
    assignment
f:x.c(17) : Warning 633: Assignment from
a strong type (FLAGS2) in context:
    assignment
```

Figure 6 - Hierarchic Type Checking

Previous versions of Lint checked only that a variable was initialised on a line prior to where it was referenced. V5 goes further. If initialisation takes place only in a `switch` statement, for example, which has no default, Lint now issues a warning (Figure 2). The fact that no other case can possibly exist is unknown to Lint, so it forces you either to avoid the warning by adding a `default` or to turn the warning off. If the variable is uniquely named in the program, you could use `-esym(644, prvpag)`. Similar checks occur for `if`, `for` and `while`.

Another improvement in Lint V5 concerns promotion of variables in a function call. V4 accepted that automatic promotion of an `int` to a `long` occurs in a function call without a cast. V5 no longer accepts this. For example, if `int save_name(long)` is called with `save_name(0)`, the warning 'Significant prototype coercion (arg. no. 1) int to long' is issued. The same happens if the argument is, say, an `int`.

V5 also checks format incompatibilities on the `printf()` family of functions, reporting such inconsistencies as `printf("%+c", cc)` and numeric size discrepancies.

Lint V5 also has a more stringent approach to overflow of constants (Figure 3). You must now be very precise about how constants are defined and manipulated.

Lint V4 got upset over certain types of `switch case` and function terminations. A common example is using `exit()` to terminate a program. If this is in a `switch` or is the last line of a function which has valid returns elsewhere, V4 complained of a missing `break` or `return`. To satisfy it, a dummy break or return had to be added (Figure 4).

Lint V5 now knows about `exit()`, among others, and allows you to define similar functions of your own. This is an aspect of another new feature, *function mimicry*, whereby you indicate that a given function has similar attributes to another.

Strength

Every now and then I think 'Wouldn't it be nice if lint...'. One thing on my wish list was a tighter rein on what can and cannot be assigned to variables defined with `typedef` and `enum`. As long as the underlying type is the same, C enforces no further type checking; an `int` which is `typedef`'d as a `BOOL` is still, at heart, an `int`.

Figure 5 shows a (contrived) case where a variable is `typedef`'d to distinguish it from others. Normally, only the programmer's eagle eye ensures this. There is no Pascal-like variable typing in C. Until Lint V5. Add `-strong(AJXB, BOOL)` to Lint's options and there is a resounding warning. For `enum`'s the level is raised to that of error. Lint also supports strong typing of pointer-indexed variables.

Strong types have a hierarchy. Hierarchy typing allows variables of a given parent type to be manipulated in terms of this parent, but inhibits interaction between the child types. In Figure 6, `FLAGS1` can be combined with `FLAGS` but cannot be combined with `FLAGS2`.

A feature of Lint which is useful for multi-module projects is LOB. The idea is to make a Lint Object Module from each finished module and to use these when linting unfinished modules. This time-saving facility lends itself to incremental linting via a make utility.

There are many more Lint facilities than can be described here. For example, indentation checking, prototype generation, redefinition of scalar variable sizes, and so on.

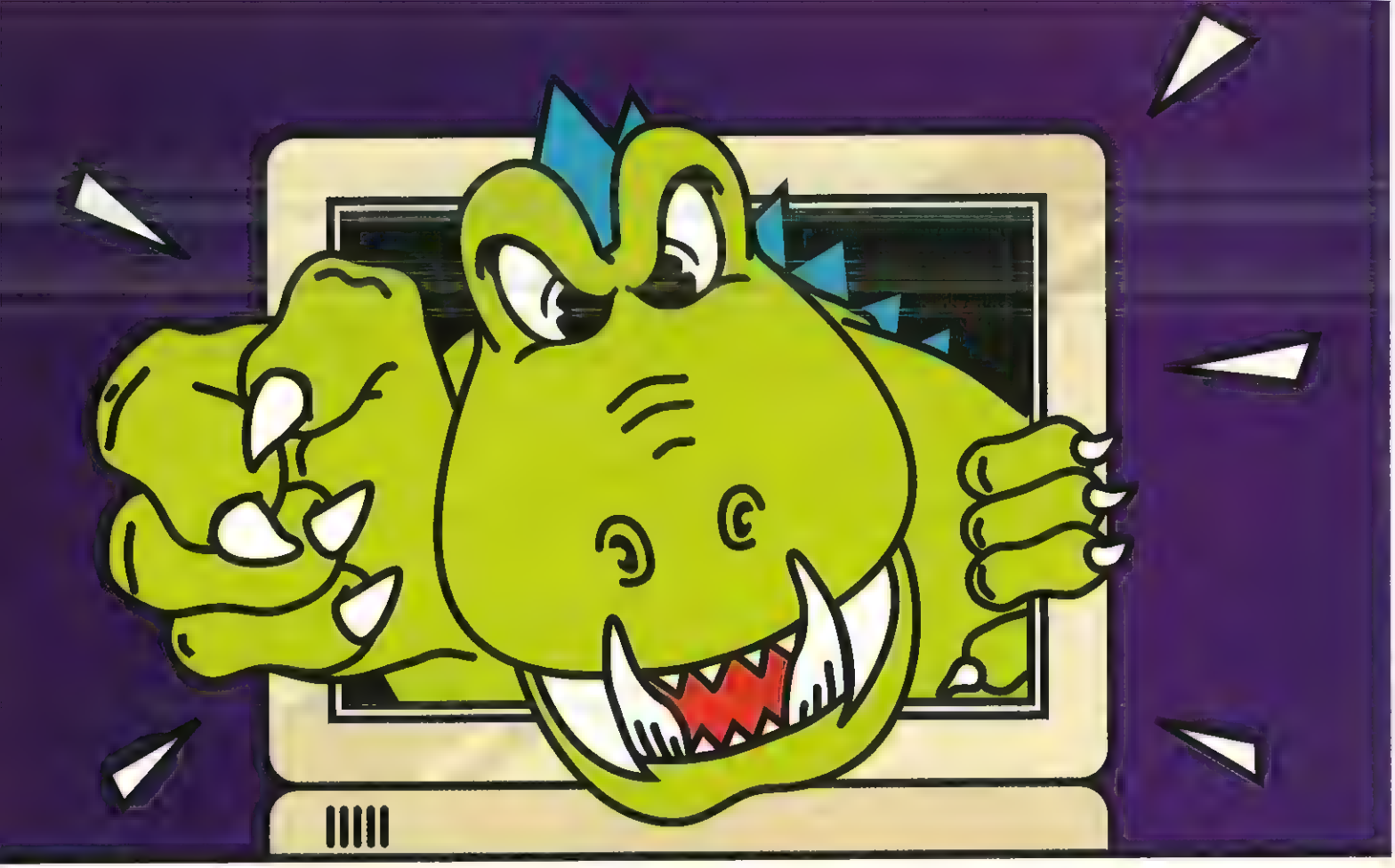
Conclusion

Gimpel's PC-Lint has always been an indispensable tool. Version 5.0 has not only addressed the odd slip-up in earlier versions, but has added an almost Pascal-like rigidity to type checking which I, for one, am grateful for.

EXE

Dave Stiles gave up a restful life of full employment to become a freelance programmer and writer. He now works twice as hard for half the money. His current hobby is sleeping until 10 am.

Gimpel's PC-Lint is available from tool suppliers such as Grey Matter (0364 53499) and Software Construction Company (0763 244114) at around £85 to £90.



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Terminally Asynchronous

Need to write Comms software?
Cliff Saran examines five alternatives to the BIOS and DOS services.

If change is a measure of progress then PC serial communications must be the computer industry's equivalent to the dinosaurs. When the PC came into existence in 1981, IBM could not possibly have conceived that it would evolve into the state-of-the-art, general purpose work-horse that it is today. We now have 486 machines which give comparable performance to the likes of minis. However, not all the silicon in the PC has been subjected to this technological bombardment - our RS232 ports are still driven by UARTs which offer more or less the same functionality as the modest 8250 that made its debut in the serial port of the very first IBM PC.

That's not all. The BIOS and DOS haven't improved their serial communications services significantly either. The BIOS provides routines to initialise the comms ports and the basic read/write character routines. It supports hardware handshaking, although the baud rate is limited to 9600. Characters are transmitted and received using polled I/O, which is inefficient since it suspends the main program until a character has been received. There are no facilities to provide Xon/Xoff software handshaking, nor are there any built-in file transfer protocols (eg Kermit or XModem). It isn't too difficult to write an alternative set of serial I/O routines that use interrupt-driven I/O (see *.EXE March 1992 - Efficient PC serial Communications*), although I wouldn't recommend that you try to re-create one of the file transfer protocols (macho programmers should look at *C Programmer's Guide to Serial Communications* by Joe Campbell for a painstaking description of the XModem protocol). This month I have been busy forging a first impression of five C comms libraries and here are my findings...

C Asynch Manager

Blaise's C Asynch Manager is a comms library that is based upon a three-level design. At the heart of the library there is Level 0, the lowest level of routines which talk directly with the UART. These routines can only be accessed from assembly language, using the 80x86's registers to pass parameters. This level contains routines which are similar to the BIOS comms services (ie initialise serial port, transmit/receive characters). However, unlike the BIOS, C Asynch Manager is interrupt-driven. Along with hardware handshaking, Level 0 also provides software flow control implemented using the Xon/Xoff protocol. Although Level 0 function can be linked with an application, Blaise also offers an alternative which installs Level 0 as a set of memory-resident routines which can be accessed using a software interrupt. The routines are permanently loaded into memory using a utility called LCOM.

```
lcom /i <intvector#> /q
```

The next layer is called Level 1 and this provides a C interface to Level 0. Characters are read from and written to separate input and output queues. The size of these queues can be specified when the port is opened. The Level 0 routines transfer data from these queues. Since a program executes far quicker than characters can be received by the UART, characters cannot be read from the input queue 'on the fly'.

	C Async Manager Library	Crystal Comm For Windows Library	Asynchronous Communications Library	Essential Communication Library	Comm-Drv
Manufacturer	Blaise 0101 415 5405441	Crystal Software 0101 906 8227994	Greenleaf 0101 214 4282561	South Mountain Software 0101 201 7626965	Willies' Computer Software Company 0101 713 4984832
Serial Card Support	PC/AT/PS2	PC/AT/PS2	PC/AT/PS2 intelligent boards from DigiBoard, Arnet & Star Gate	PC/AT/PS2 Intelligent boards from DigiBoard	PC/AT/PS2 DigiBoard COM/Xi
File Transfer Protocols	XModem, YModem	XModem, YModem, Kermit	XModem, YModem, ZModem, Kermit	XModem, YModem, ZModem, Kermit	Vendor specific
BackGround File Transfer	Y	N	N	Y	N
Max Baud Rate	19200	19200	115200	115200	115200
Hayes Support	Y	Y	Y	Y	N
Levels in Lib	3	1	3	2	1
Num of Lib calls	57	49	298	120	94
Mem Resident	Y	N	N	Y	Y
Price	£110 Grey Matter	$350	£175 Grey Matter	£150 Grey Matter	$89.95

Note that PC/AT/PS2 refers to support for the 8250/16450/16550 UARTs respectively. Prices quoted are for the source code versions of the libraries.

Figure 1 - Comparison of Comms Libs

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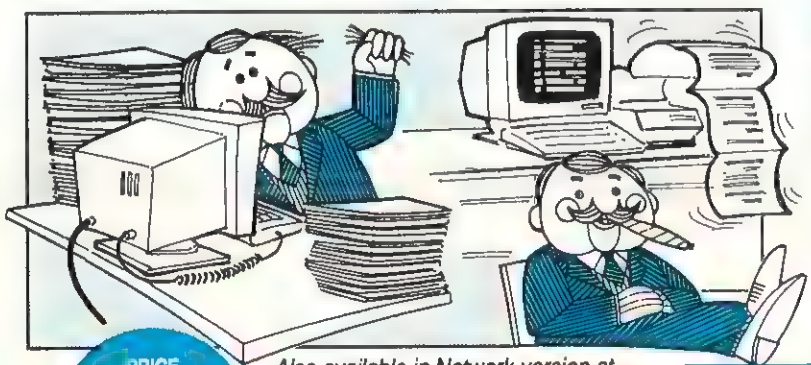

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When you need to read a character from a comms port it is necessary to synchronise the execution of the program with the rate at which characters are received. Level 1 provides `iwait_a1()` which halts program execution until a character has been put in the input buffer. Conversely, it is sometimes necessary to synchronise the transmission of characters. Blaise provides the `drain_a1()` routine for this purpose. `drain_a1()` waits until all characters have been transmitted before returning to the program.

The topmost layer in C Asynch Manager is Level 2. This contains a set of routines that are supposedly easier to use than their Level 1 counterparts, although this is questionable. Level 2 doesn't offer any substantial improvements over and above Level 1 so why should you use it? The only improvement worth a mention is Level 2's straightforward approach to port configuration. In Level 2 Blaise has thoughtfully provided a structure which enables all options to be changed in one go, while in Level 1 it is only possible to change one setting at a time.

C Asynch Manager supports both the XModem and the YModem file transfer protocols. It uses a complicated structure (`FTCS`) to hold all the information required to perform a file transfer. Since `FTCS` contains all the info needed to perform a file transfer, Blaise has designed the Upload/Download routines such that they can run in the background. This means that an application does not have to suspend execution until a file transfer has completed.

C Asynch Manager is able to control a Hayes compatible modem. It provides several routines including functions for picking up the receiver, dialling, auto-answering and hanging-up. Commands can be sent to the modem as strings using the `cmd_hm()` routine.

CrystalComm

CrystalComm for Windows from Crystal software is the only library of the five that is distributed as a DLL and can be used to develop Windows-based comms applications. There is also a version of the library available for DOS. Unlike C Asynch Manager, CrystalComm is organised as a single layer of routines. Almost all routines in the library take a comms port handle as their first parameter. The one exception is `ComOpen()` which returns such a handle.

Serial communications is interrupt-driven so it is necessary to check whether there are characters in the input queue before reading it. CrystalComm doesn't provide a routine which suspends program execution until a character has been received. Instead it contains a function (`ComStatus()`) which returns the number of characters in the input queue. In order to synchronise program execution with serial input it is necessary to repeatedly call `ComStatus()` until it returns a positive integer.

While polling, the program can perform other chores - characters will not be lost unless the input queue overflows. As an alternative, CrystalComm also provides `ComReadTimed()` which waits for a character to arrive until a pre-defined timeout occurs. The review copy of this library doesn't allow the programmer to check whether the output queue is empty. However, a new version of CrystalComm will be available shortly which will provide this facility.

There are three methods of file transfer available to the programmer. Unlike C Asynch Manager, CrystalComm supports the Kermit file transfer protocol. The function `ComSetKermitParams()` allows you to tweak the various options available. However the default values seem to work pretty well. CrystalComm also supports the XModem and YModem file transfer protocols although.

CrystalComm also provides routines for controlling a Hayes compatible Modem. Unlike C Asynch Manager, CrystalComm doesn't allow the programmer to specify a Hayes command string directly.

Glossary

Asynchronous Communications - A type of serial communications in which each character is passed from the transmitter to the receiver as an independent entity, consisting of a *Start Bit*, up to two *Stop Bits* and an optional *Parity Bit*.

Baud Rate - The frequency at which electrical impulses are sent down the communications line.

Bits Per Second - The number of data bits transmitted per second.

Checksum - A method used to determine whether a block of characters has been received correctly. This normally involves summing the ASCII values of all characters received and comparing the least-significant byte of the result with a separately transmitted checksum byte.

CRC - (Cyclic Redundancy Check) A more powerful method for detect transmission errors than *Checksum* (for a detailed explanation see *C Programmer's Guide to Serial Communications* by Joe Campbell).

CTS/RTS - These two signals provide a *Handshaking* mechanism for serial communications. The transmitter sends Request To Send signal to the receiver which responds with a Clear To Send if it is ready to receive.

Download - This is the process of receiving one or more files from a host computer (see also *Upload*).

Full-Duplex - The ability to transmit and receive information simultaneously (see also *Half-Duplex*).

Half-Duplex - Communications can occur in both directions but it is limited to one direction at any given moment in time (see *Full-Duplex*).

Handshaking - A mechanism which enables the receiver to remain in synchronisation with the transmitter (see *CTS/RTS*).

Hayes Compatible - Modem conforms to the Hayes communication standard and can be controlled using a set of instructions known as the AT Command Set.

Interrupt Driven Comms - This provides the most efficient way of transmitting and receiving serial data. It effectively enables serial communications to occur in the background while the main program runs in the foreground.

Kermit - This is a file-transfer protocol which enables batches of files to be transferred to or from the host (see *XModem*).

Parity - Error-detection that works on a per-character basis. A Parity bit is an addition bit that is appended to the end of a character to be transmitted in order to make the resulting byte hold either an even or odd number of bits set to one.

Polling - A simple method of achieving serial communication which relies on the software continually checking the *UART's* status register to determine whether it is ready to transmit or receive a character (see Interrupt-driven Comms).

RS-232 - The Electronics Industries Association (EIA) standard which describes the behaviour of the electrical signals needed to perform serial I/O.

Start Bit - This is a synchronisation pulse which informs the receiver that the first bit of a character will be transmitted next (see *Stop Bit*).

Stop Bit - Another synchronisation pulse which tells the receiver that the last bit of a character has been transmitted. There may be 1 or 2 Stop Bits (see *Start Bit*).

UART - (Universal Asynchronous Communications Adapter) A device which controls serial communications.

Upload - This is the process of transmitting one or more files from a host computer (see *Download*).

XModem - A file transfer protocol which enables a single file to be *Uploaded/Downloaded*. Data is transferred in packets of 128 bytes and each packet is associated with *Checksum* or *CRC*.

Xon/Xoff - A protocol which lets the receiver control the flow of characters down the transmission line. If the receive buffer becomes full, the receiver sends a special Xoff character to inform the transmitter to stop sending characters. When it is able to receive again, the receiver sends an Xon character.

YModem - This is an enhancement to the *XModem* protocol which enables multiple files to be transferred. The packet size is increased to 1024 bytes and there is an extra packet at the start of the transfer which consists of a file list and size and date information.

ZModem - This is a further extension to the *XModem* family of file-transfer protocols and provides rapid file transfer.

CommLib

Greenleaf's CommLib is based on a three level hierarchy. However, unlike Blaise, Greenleaf takes full advantage of the three layers. The lowest level, Level 0, talks directly to the hardware. Level 1 provides a C interface to Level 0 and Level 2 enables the programmer to write device-independent software. Unlike the two previous libraries, Commlib contains several device drivers in addition to the 8250 driver. These include the Arnet, DigiCHANNEL and Star Gate intelligent serial cards together with a number of non-intelligent cards. The Level 2 library routines provide a consistent, device-independent interface to these device drivers.

CommLib maintains this device-independent interface by providing a `PORT` data structure that holds pointers to the routines which apply to a given serial card. When a function such as `ReadChar()` (read a character from serial port) is called, CommLib uses the `PORT` structure to invoke the correct device-specific routine which is then used to perform the actual read operation.

The input buffer must be polled in a manner similar to the method adopted in CrystalComm to check when a character has arrived. However Greenleaf also allows the programmer to determine whether the output buffer is empty. In addition, it provides routines which return how much space is free in the receive and transmit buffers.

CommLib offers the programmer an impressive list of built-in file transfer protocols. In addition to providing several variants of the XModem/YModem and Kermit protocols, it also enables files to be transferred using ZModem. Instead of providing a structure to hold the settings of the various options for each file transfer protocol, CommLib uses different versions of the library calls. For instance, the function `XmodemlKCRCSend()` will transmit a file using XModem with a 1 KB packet size and CRC error checking. On the other hand, `XmodemChecksumReceive()` will transmit the same file using XModem with a 128 byte packet size and checksum error checking. There are four versions of XModem, three versions of YModem, two versions of Kermit and two versions of ZModem.

In addition to supporting the usual modem controls (eg Dial, Hang-up), CommLib provides a comprehensive list of routines for controlling the modem. CommLib also includes a number of routines for writing terminal emulation or Bulletin Board Service (BBS) software. There are functions for controlling the keyboard and a set of functions for providing a 'no frills' DOS-based windowing system.

Essential Comms

The Essential Communications Library (ECL) from South Mountain Software is a two-level library that supports a number of serial port cards. ECL's equivalent to Blaise's Level 0 routines is the XCommS (eXecutive Communication Server) - a rather extravagant name for a set of routines which talk directly to the hardware (ie device drivers). However, unlike C Asynch manager, it is not possible to access these routines from C. XCommS may be linked with an application or, alternatively, it can be loaded as a memory-resident module using the XCOMMS utility. The command-line below will cause XCommS to load into memory, set aside

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eight receive buffers and use COM1 with Xon/Xoff flow control.

```
xcomms 8  com2x
```

Access to Level 0 is achieved through the Level 1 C interface code. Level 1 provides drivers for five serial port cards which include the DigiBoard PC/Xe intelligent board and a number of non-intelligent boards with multiple serial ports. It also contains a generic driver which lets you configure ECL to work with other, unsupported multiple serial port cards. For instance, the following code extract will provide support for two comm ports on IRQ3, with COM2 at address 0x2F8 and COM3 at 0x3220. This is the configuration of the PS/2's dual async adapter.

```
xc_entr(5);
setport(0x2F8, 2, 3, COM2, 0);
xc_cport(COM3, 0x3220);
```

Initialising a comms port is perhaps a little peculiar - you have to tell ECL to operate with interrupt-driven I/O, otherwise it assumes that you intend to use the BIOS serial communications service. You also have to indicate how many input buffers your application requires. Unlike other libraries in this review, the size of the input buffer is fixed at 1 KB.

South Mountain Software has taken Blaise's approach to synchronising serial communications. It provides routines which suspend program execution until a character has been successfully transmitted or received.

ECL supports the XModem, YModem, ZModem and Kermit file transfer protocols. The various options are passed as parameters to the appropriate routine. This is more elegant than providing several versions of each routine (as in CommLib), although it is less flexible than Blaise's `FTCS` structure.

There is Hayes-compatible modem control and support for basic keyboard and video I/O. A unique feature of ECL is that it supports the emulation of three types of terminals (VT52, VT100 and ANSI). The `terminal emulation routines` use a `term_info` structure to describe the physical characteristics and behaviour of a given terminal.

Comm-Drv

Comm-Drv is a basic communications library from Willies' Computer Software Company (WCSC). There are three versions of the library. The first is a replacement for the BIOS comms services. It uses a memory-resident module called CommTSR to provide the serial I/O services. The module can be accessed from assembly language by invoking interrupt 14. For instance, the code below will send an asterisks character to COM1.

```
mov AH, 01h
mov AL, '*'
mov DX, COM1
int 14h
```

Next there's an MS-DOS device driver. This enables a programmer to access Comm-Drv using standard Open, Close, Read, Write and IOCTL calls. The last version of Comm-Drv is a C interface which contains an embedded form of the CommTSR.

Comm-Drv uses the port number to access the serial port. When it is time to configure the port, Comm-Drv adopts a similar mechanism to C Asynch Manager. It provides a `port_param` data structure and the `ser_rs232_setup()` routine for configuring the port using the values contained within this structure. There is also a routine for reading the current configuration of the port.

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Comm-Drv provides its own file transfer mechanism. The usefulness of this protocol is questionable since it is necessary for the remote machine to be running `ser2xfer_slave()` in order to transfer files. WCSC does offer a support library for Comm-Drv called Comm-Log which provides the programmer with background XModem and YModem file transfer.

This can be purchased separately for $89.95. WCSC also offers Comm-LOG and Comm-Drv together for $159. There is no modem support.

Conclusion

There's no need to list the similarities between these five libraries, as I'm sure you have already browsed thorough the table in Figure 1. There are a few notable differences worth a mention.

The XModem family of protocols was introduced in 1977 by Ward Christensen and it is historically significant because it was one of the first to be used for transferring files between IBM PCs over phone lines. Before XModem, Kermit was the most widely used protocol. Even today, there are some systems that only support Kermit file transfer.

If you want your comms software to operate with most computer systems, Kermit support is essential. This prevents you from using either C Asynch Manager or Comm-Drv.

ZModem was developed in 1986 by Telenet and offers significant enhancements over XModem and YModem including compatibility with satellite links and packet switched networks. Writing software for an uncertain future is a daunting task. However, if you're planning on supporting ZModem file transfer, it is likely that your communications software should survive for at least another decade. There are only two libraries in this review that support ZModem and these are Greenleaf's CommLib and South Mountain Software's Essential Comms Library.

Perhaps you're simply looking for better serial I/O. In this arena, the five libraries clearly offer a far superior interface to the BIOS. The question here is, which one is the easiest to use. The first stumbling block is in the quality of the documentation. C Asynch manager, CommLib and ECL come with extensive, well presented reference manuals. My first impression of the CrystalCOMM reference manual is that it was an afterthought - it provides only the barest of information needed to use the library. Comm-Drv is only slightly better.

Next there's the design of the library. The more levels of library call you have, the easier the library is to use. Finally there's support for non-standard hardware. A library that provides built-in support for specific hardware is certainly better than one that provides no support at all.

My personal favourite is Greenleaf's CommLib, with ECL a close second. As a final thought, whichever library you decide is best for you, I can guarantee that it will offer significant improvements over the ancient BIOS serial I/O services.

EXE

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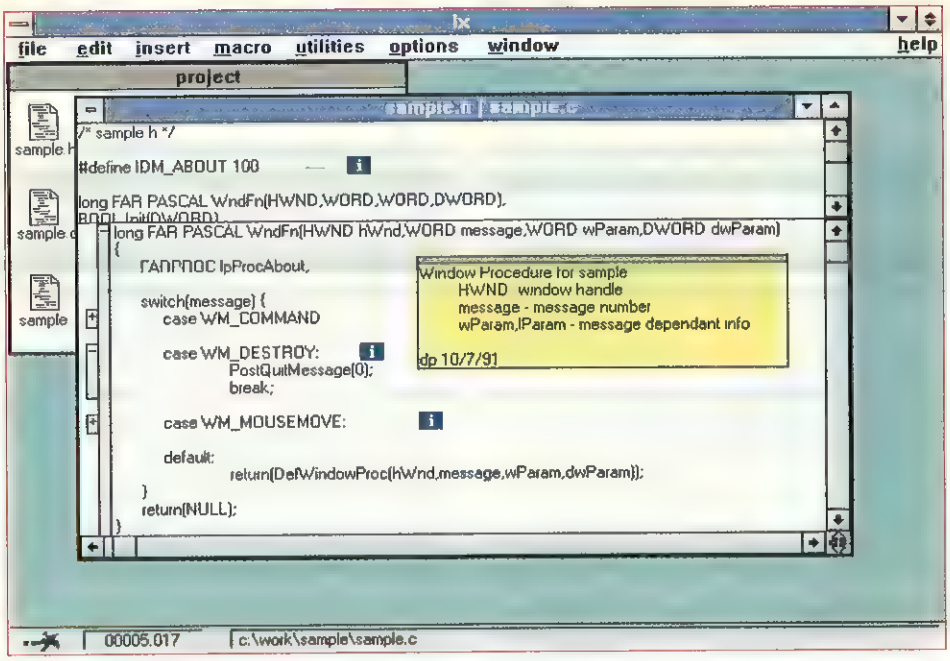

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As more and more users switch to Windows 3, the demand for Windows software continues to grow. Yet much of the developer's toolkit still runs under DOS. Writing for Windows has always been more complex than for DOS, and project management can be especially tricky as Windows programs tend to be made up of large numbers of files.

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Let me list the ways

Michael J Marshall explains how the humble linked list has saved him many hours of development time.

One of the most important rules of programming is to design for reusability whenever possible. This means: avoid writing purpose-built structures when a more generic structure already exists. Existing code has already been tested (probably in many different applications), so placing it in new code effectively removes a possible cause of bugs when testing the code. And since `TIME == MONEY` (according to my boss), the less time spent coding and debugging, the better.

One of the most useful data structures I've come across is the linked list. Every single programming book I've encountered has at least one implementation of linked lists. Unfortunately, a lot of these books underplay the usefulness of this simple container. It can be used to hold any number of effectively arbitrary objects and allows simple sequential retrieval of those objects. Implementation of linked lists is also quite trivial in most computer languages, which is a major plus - the simpler the code, the less likely it is to have hidden bugs.

Linked lists will benefit any program that needs a dynamically sized container with sequential access. If speed and size are an issue, you can replace the generic list with a purpose-built optimised version after you've got the rest of the application debugged.

```
/*
** SLIST.H
** Linked List Header File
** Michael J Marshall - X-ON Software
*/
#if !defined( _SLIST_H )
#define _SLIST_H
#if !defined(OK)
#define OK  0
#define FAIL  (-1)
#endif
/* Macros */
/* Returns no of elements in the list. */
#define slCount(list) \
   ((list)?(list)->count:0)
/* Short forms for traversing a list. */
#define slFirst(list) slIterate((list),1)
#define slNext(list)  slIterate((list),0)
/* Type Definitions */
typedef void (*free_t)( void * );
typedef int (*compare_t)( const void *,
                          const void * );
typedef struct SLNode {
  struct SLNode *next;
  void *datum;
} SLNode;
typedef struct SList {
  SLNode *head;
  SLNode *tail;
  SLNode *curr;
  unsigned count;
} SList;
 * Prototypes */
SList *slNew( void );
void slFree( SList *list, free_t del );
void slClear( SList *list, free_t del );
int slInsert( SList *list, void *datum );
int slAppend( SList *list, void *datum );
void *slGet( SList *list );
void *slIterate( SList *list, int start );
void *slSearch( SList *list, void *key,
                             compare_t cmp );
int slDelete( SList *list, void *data );
void *slSelect( SList *list,
                unsigned pos);
void *slCurr( SList *list );
#endif
```

Figure 1 - SLIST.H header file

```
/*
** SLTEST.C
** Linked List Test Program
*
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "slist.h"
void main( void )
{
  SList *list;
  char *str;
  list = slNew();
  if ( !list )
  {
    puts( "slNew() failed!" );
    return;
  }
  for ( ;; )
  {
    char buf[80];
    printf("Enter a string, \
<ENTER> to stop: " );
    gets( buf );
    if ( !buf[0] )
      break;
    /* NB Append a copy of the string */
    slAppend( list, strdup( buf ) );
  }
  printf( "\nThere are %d strings in \
the list:\n", slCount( list ) );
  for ( str = slFirst( list );
        str; str = slNext( list ) )
    puts( str );
  /* Free the list and all of the
     strings in it */
  slFree( list, free );
}
```

Figure 2 - SLTEST.C source file

The SList Package

SList is my implementation of linked lists. I wrote it a couple of years ago, and although I have added a few new features to it and improved its performance a bit, it is stable and reliable. It is easily the most useful element in my library.

The package itself is quite simple. It stores pointers to data created by the application, and returns them on request. You can add data at the beginning or end of the list, allowing simulation of queues and stacks. You can iterate over the list's elements, search the list for a specific datum, and remove items from the list.

Implementation

The interface to the SList package is defined by the macros and functions provided. The implementation is irrelevant to the user as long as the semantics of the defined interface are maintained. This encapsulation definitely helps maintenance, because if I completely rewrite the implementation of SList, the most work I will have to do on other code that uses SList is recompile it (because of the macros) - not a single line of code should need to be changed.

For return values, I follow the general ANSI/UNIX convention of returning 0 on success and -1 on failure.

The list keeps track of both the head and tail elements, which greatly simplifies the `slInsert()` and `slAppend()` operations.

SList's can be used for creating stacks and queues as well as plain lists. The `slSelect()` function could be used to implement a sort of dynamic random-access array, which although functional, would be quite slow.

The Code

Figures 1 and 3 contain the source code and header file for the SList package. Figure 2 is a test program for the SList package. The user just enters strings, which get stored in a list. An empty line terminates the input, and the list contents are then printed to the screen. A trivial program, but it does demonstrate a function I often use lists for: string storage.

The code has been tested with Borland C++ 2.0, and there is nothing in the code that will prevent it being ported to any ANSI compiler under any operating system.

Conclusion

I've used lists in all sorts of programs. They're not the most efficient of data structures, but if speed and size are not critical, their pure simplicity can provide amazing power with no costly development time. Who says you can't get something for nothing?

EXE

Michael John Marshall is a software engineer for X-ON Software, a City based software house. An American import, his interests beyond computers include science fiction, mythology, and origami. Michael can be reached on 071 522 0088, or michael@xon.co.uk

```
/*
** SLIST.C
** Linked List Package
** Michael J Marshall - X-ON Software
*/
#include <stdlib.h>
#include "slist.h"
/* Private Functions */
/* These functions can be rewritten to
   provide more sophisticated allocation
   schemes. My development version
   maintains a free node list.
*/
/* Returns a new list node,
   or NULL on error. */
static SLNode *newnode( void )
{
  return malloc( sizeof( SLNode ) );
}
/* Deletes a list node. */
static void freenode( SLNode *node )
{
  free( node );
}
/* Public Functions */
/* Creates a new, empty list.
   Returns the list, or NULL on error. */
SList *slNew( void )
{
  SList *list = malloc( sizeof( SList ));
  if ( list )
  {
    list->head = list->tail = NULL;
    list->curr = NULL;
    list->count = 0;
  }
  return list;
}
/* Destroys a list. If the del argument
   is not NULL, the provided function is
   used to destroy the list elements. */
void slFree( SList *list, free_t del )
{
  register SLNode *curr;
  if ( !list )
    return;
  for ( curr = list->head; curr; )
  {
    SLNode *next = curr->next;
    if ( del )
      /* delete the datum */
      del( curr->datum );
    /* delete the node */
    freenode( curr );
    curr = next;
  }
  free( list );
}
/* Similar to slFree(), except the list
   just emptied, not destroyed. */
void slClear( SList *list, free_t del )
{
  register SLNode *curr;
  if ( !list )
    return;
  for ( curr = list->head; curr; )
  {
    SLNode *next = curr->next;
    if ( del )
      /* delete the datum */
      del( curr->datum );
    /* delete the node */
    freenode( curr );
    curr = next;
  }
  /* reset the list */
  list->head = list->tail = NULL;
  list->curr = NULL;
  list->count = 0;
}
/* Adds a new element at the head of the
   list. Returns OK/FAIL. */
int slInsert( SList *list, void *datum )
{
  SLNode *node;
  if ( !list || !datum )
    return FAIL;
  if ( node = newnode() )
  {
    node->datum = datum;
    if ( list->head )
    {
      /* Insert into existing list */
      node->next = list->head;
      list->head = node;
    }
    else
    {
      /* First element in the list */
      list->head = list->tail = node;
      node->next = NULL;
    }
    list->count++;
    return OK;
  }
  return FAIL;
}
/* Adds a new element to the end of the
   list. Returns OK/FAIL. */
int slAppend( SList *list, void *datum )
{
  SLNode *node;
  if ( !list || !datum )
    return FAIL;
  if ( node = newnode() )
  {
    node->datum = datum;
    node->next = NULL;
    if ( list->tail )
    {
      /* Append to existing list */
      list->tail->next = node;
      list->tail = node;
    }
    else
    {
      /* First element in the list */
      list->head = list->tail = node;
    }
    list->count++;
    return OK;
  }
  return FAIL;
}
/* Retrieve the first element of the list
   and remove it. */
void *slGet( SList *list )
{
  if ( list && list->head )
  {
    void *datum;
    SLNode *node   list->head;
    list->count--;
    list->head = node->next;
    if ( !node->next )
      /* Removed only element in list */
      list->tail = NULL;
    datum = node->datum;
    freenode( node );
    return datum;
  }
  return NULL;
}
/* Used to iterate over a list
   non-destructively. If start is
   non-zero, the iteration is (re)started.
   Returns the next item in the
   list of NULL when the list has been
   exhausted.
*/
void *slIterate( SList *list, int start )
{
  if ( !list )
    return NULL;
  if ( start || !list->curr )
    /* Start iteration */
    list->curr = list->head;
  else if ( list->curr )
    /* Advance to next element */
    list->curr = list->curr->next;
  return ( list->curr ?
           list->curr->datum : NULL );
}
/* Searches the list for the first
   element that matches key, as defined
   by comparison function cmp, which
   should act similarly to strcmp().
   Returns the element if found, or NULL
   otherwise.
*/
void *slSearch( SList *list, void *key,
                compare_t cmp )
{
  register SLNode *curr;
  if ( !list || !key || !cmp )
    return NULL;
  for ( curr = list->head; curr;
        curr = curr->next )
  {
    if ( cmp( key, curr->datum ) == 0 )
      return curr->datum;
  }
  return NULL;
}
/* Removes the specified element from
   the list. Datum is the element in the
   list to delete. Returns OK if deleted,
   FAIL otherwise.
*/
int slDelete( SList *list, void *datum )
{
  register SLNode *curr;
  SLNode *prev = NULL;
  if ( !list || !datum || !list->head )
    return FAIL;
  for ( curr = list->head; curr;
        curr = curr->next )
  {
    if ( curr->datum == datum )
    {
      if ( !prev )
        /* Removing first element */
        list->head = curr->next;
      else
        prev->next = curr->next;
      if ( !curr->next )
        /* Removing last/only element */
        list->tail = prev;
      if ( list->curr == curr )
        /* Removing current element
                              - back up */
        list->curr = prev;
      freenode( curr );
      list->count--;
      return OK;
    }
    prev = curr;
  }
  return FAIL;
}
/* Returns the Nth item in the list
   (0 for first item). Returns element
   or NULL.
*/
void *slSelect( SList *list,
                register unsigned n )
{
  register SLNode *node;
  if ( !list || n >= list->count )
    return NULL;
  for ( node = list->head; n--;
        node = node->next )
    ;
  return node->datum;
}
/* If there is a current element,
   returns it, otherwise returns NULL. */
void *slCurr( SList *list )
{
  return ( list && list->curr ) ?
    list->curr->datum : NULL;
}
/* END SLIST.C */
```

Figure 3 - SLIST.C source file

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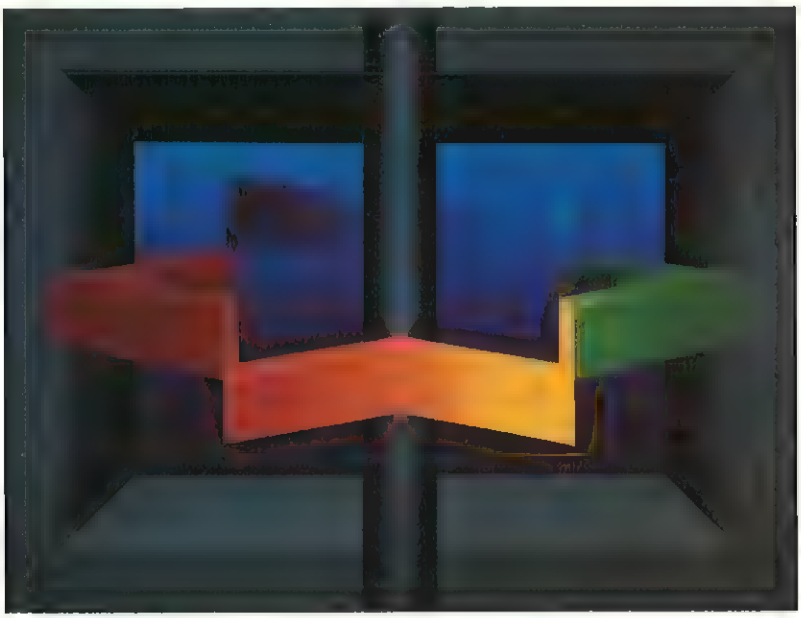

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CIRCLE NO. 938

Patently obvious?

Richard Stallman, the man who started the League for Programming Freedom, has just completed a lecture tour of Britain. What does he think, and are we to take him seriously?

Suppose you invent a machine, and start manufacturing it. Any other company which can take it apart and find out how it works can start manufacturing it in competition with you. All your hard work involved in inventing and developing the machine now has to be shared with the other manufacturer, while they have contributed nothing to your effort. The situation is clearly unfair, so almost every country in the world operates a patent office. The idea of the patent office is that you can register your idea, and if the idea really is yours you will be granted a legal monopoly over the invention for a certain length of time. If anyone starts using your invention without your permission, you have the right to sue him.

"THERE ARE RESTRICTIONS ON WHAT YOU ARE ALLOWED TO PATENT"

There are restrictions on what you are allowed to patent. The law says that an application must describe a process or a machine which fulfils a specific purpose. Mental steps, mathematical processes, and computer programs are, therefore excluded. Certain types of machine are explicitly excluded, such as perpetual motion machines and anti-gravity machines, whether or not a working model can be demonstrated. Finally, the idea may not be public domain, it must not be obvious, and it must be the original property of the applicant. Because they are legal documents, lawyers must be employed by the applicant in order to cover the maximum possible territory with a single application. The situation in the US was, until recently, pretty much the same as it is here, until 1981 when *Diamonds v. Deibr* accidentally allowed software to be the subject of a patent. Since then a number of extremely questionable patents have been filed. Cadtrak, a company which exists solely to manage software patents, owns a patent which describes the use of exclusive-or to draw erasable cursors onto a computer screen. IBM owns patents which describe register optimisation in compilers, among others. The US patent office granted these patents, in spite of the fact that they seem to be obvious.

Naturally, this has generated a great deal of ill-will. The patent system is flawed. It is not hard to find all kinds of injustices, in this country as well as in the US. One can violate a patent that even an exhaustive search will not reveal (because the application is merely listed, not filed), and the resulting patent can be applied retroactively (one of the few retroactive laws we have). As the above cases show, the patent office themselves are not capable of assessing the (extremely technical) applications - when Quantel went to court in Britain with more than 60 patent claims (all of which were questionable in the terms of the act) many were amended at the trial before Spaceward was found in breach of them. And conferring an inventor with the right to sue an infringer is precious little use to most people - the costs involved prevent a private individual from suing a company of any size.

Now there is certainly a case to be made for reforming the patent system, but many people want to go further than that - they want software patents eradicated for good. I had real trouble with this concept - I couldn't see the difference between inventing in a workshop and inventing at a keyboard. After all, if someone spends years working on something, he has the right to expect a fair compensation for his effort. Richard Stallman disagrees. He sees a real difference between the two cases. Richard Stallman is the head man at the League for Programming Freedom, a pressure group set up to campaign against software patents. According to Stallman, writing in the ACM Communications (January 1992), software is different because a programmer's job is to invent.

I believe that software patents are very dangerous, and will do immense damage to the industry

Every programmer solves original problems in original ways, and many original solutions appear time and time again as they are re-invented by other programmers facing similar problems. He claims that a program of 50,000 lines is of about the same complexity as a car. The program can cost as little as a few tens of thousands of dollars to develop, and the car will cost many millions. They will both impact upon about the same number of patents. And here is the problem - if patent licensing costs about $100,000 in both cases (searches, lawyers costs, negotiation, and so on), the impact on the car will be negligible, but the impact on the program will be devastating.

I would like to add one further observation to this. When a patent is granted, it confers a monopoly on the applicant to use and develop the invention in all its forms. Practically all programmers, and most mathematicians hijack simple ideas with which to get a handle on the problem - the IBM patent about register optimisation specifically talks about colouring. The problem is, if a different solution can be shown to be equivalent to that described in a patent (either by changing the words, or by a mathematical transformation) then the new solution infringes the patent. Showing equivalence is not a trivial problem, and even if a proof could be established, its mathematical correctness will always be in some doubt. Court-rooms are not the place to argue maths!

I have now come round to Stallman's view. I believe, like him, that software patents are very dangerous, and will do immense damage to the industry. Although forbidding software patents will harm a few people, on a large scale the industry is inventing prolifically without any protection other than simple confidentiality, and we don't need them. We don't want them here, and the US should abandon them before the damage there is irrecoverable. The issues are too complex to allow them to be decided by ill-informed and barely applicable case law.

Postscript In the course of writing this item, I made contact with Stallman. Among the information he sent me was the following; 'Negotiations for the GATT (General Agreement on Tariffs and Trade) are continuing based on a working draft proposed in December as a compromise by the head of GATT. The draft would require all countries that accept the agreement to have patents that cover software techniques. It would also rule out all the ideas so far proposed to protect software from patents or to make the patent system bearable for software developers.'

The draft treaty covers all aspects of international trade, and it will be presented to the US Senate as a package deal. The result would be irresistible pressure to adopt the whole package. 'Thus, sweeping changes in US intellectual property law would be forced upon us and cast in stone, without any consideration by the House of Representatives, and with no opportunity for the Senate to consider them individually on their merits. At the same time, legal policy which Congress currently has the power to change would become frozen and unchangeable.'

GATT is intrinsically an international treaty, and I am advised that it is being considered here. The clause-by-clause commentary that Stallman sent me was truly frightening. Unless something is done soon, the damage will be irreparable.

EXE

Jules is an independent programmer and consultant who would be put out of business overnight if software patents were to be implemented in Europe. Chances are, so would you. He can be contacted on 0707 44185 or on CIX as `jules`. *The League for Programming Freedom can be contacted at 1 Kendall Square #143, PO Box 9171, Cambridge, MA 02139, phone 0101 617 243-4091 (from the UK), or at* `{league@prep.ai.mit.edu}`. *They are actively seeking new members.*

Contain Yourself!

There's lots of press about all the time spent (re)writing user interface code. But what about the other parts of your programs?

If half the bulk of a given project is user interface code, another 20 percent is data structures and their related functions. In particular, much time is spent developing data structures whose sole purpose in life is to contain collections of other data structures. In object-oriented circles such data structures are aptly called 'Containers'. Just as you can save time by using (or developing) a general purpose user interface library, you can also benefit from a general purpose container library.

Internally, containers can be implemented in many ways; as complicated as a wild variation of an undirected graph or as simple as an array, depending on the characteristics of the data being contained and how it will be accessed. Externally, the container can be thought of either in terms of its internal implementation, or in terms of its use characteristics (eg sometimes an unsorted array is called a 'Bag'). Examples of common container implementations are: Vector, SList (singly-linked), DList (doubly-linked) and BTree. Some common external views are: Set, Dictionary, Stack, Queue, Dequeue, and SortedCollection. Note that most of these external views could be internally implemented in several different ways (a Stack could be implemented as either a Vector or an SList, for example).

In a traditional programming language, the functions for manipulating data in a container (eg `Insert()`, `Get()`) would have to be rewritten for each different type of data to be stored in the container. C++ and other object-oriented languages allow you to write the container functions once and reuse them for several different types of objects. As a matter of fact, there are at least three different commonly used methods (in C++) for constructing reuseable containers. In the next few pages, I'll show you how each of these methods works and hopefully enlighten you to the relative merits of each.

Three Roads

The first type of container we'll discuss is the traditional '`void*`' container pioneered by Bjarne Stroustrup in the original *C++ Programming Language* and carried on in particular by the Zortech C++ Tools library. The basic concept of this method is that a) the same functions can work for different types of objects only if the size of the object is always the same, and b) as pointers are the same size no matter what they point to, storing pointers to objects in the container, rather than the objects themselves, allows reusing the same function code for different types of objects. Using `void*` circumvents most type-checking problems, as a `void*` is defined to be 'a pointer to anything' (quite different from a `void`, which is 'nothing')

The second method, '`Object*`' containers, is similar to the first, except that rather than having a container filled with `void*`, we make a container filled with `Object*`, where Object is a base class from which all other objects stored in a container must be derived. Borland C++'s Classlib implements this type of container.

The third method uses C++ 'templates'. This is similar to generic packages in Ada - you create a template with a place-holder where the actual object type will go. The template will later be used to generate container classes and their member functions as needed. As templates are fairly new to C++, many compilers don't yet implement them - BC++ 3.0 is one which does.

An Example

For the rest of this article, we'll be working with a simple example: a priority queue (call it `PQueue`). Data is inserted into a `PQueue` according to its priority (sorting order) relative to the items already on the `PQueue`. When data is requested from the `PQueue`, the item with highest priority is always given first. If two items have the same sort order, they are given back in 'First In First Out' (FIFO) order.

I have chosen `PQueue` because its implementation is relatively short, while still showing some of the problems that must be overcome in creating a reuseable container. In particular we need to compare two items to determine their relative priority (in `Insert()`), as well as needing to dispose of items (in `Clear()`).

Internally, I have implemented `PQueue` as a singly-linked list.

The test program for each method shows how to declare a `PQueue` of `int`s, and does a few `Insert()`s and `Get()`s to test it out.

void* Containers

Figure 1 shows `VPQueue`, an implementation of a `PQueue` using the '`void*`' method. First a `VNode` class is created to represent each node on the list - a `void*` for the data and a `VNode*` for the next item on the list. `VNode` will remain unchanged no matter what types of objects are stored on the `VPQueue`.

`VPQueue` contains a few twisters, however. The first problem encountered is that, in `Insert()` we must compare the priority of two objects to determine where the new object should be placed; unfortunately, `VPQueue::Insert()` itself cannot know how to compare these two objects, as it doesn't know their type. Virtual functions come to the rescue, with a `VPQueue::Greater()` function which can be redefined in later `VPQueue` descendants to cast the `void*` to the actual type, then do the compare (see `intVPQueue` in listing 1 for an example).

A similar problem occurs in `VPQueue::Clear()` when we try to delete objects as we remove them from the queue; calling `delete` itself would just dispose of the memory directly holding the object - any memory pointed to by the object would be left floating. This can also be solved by a virtual function, which we'll call `VPQueue::Destroy()`. `Destroy()` is redefined in later classes to cast its `void*` argument to the object's actual type, then call `delete`. This typecast makes sure that the object's own de-

structor is called, as well as the object's memory being freed. (My version of Zortech Tools just deletes the object as a `void*`, which leads to dangling memory allocations. So watch out!)

```
//              VPQUEUE.H
class VNode
  {  // one node on the Queue
  friend class VPQueue;
  void *data;
  VNode *next;
  VNode(void *d, VNode *n)
    { data = d; next = n; }
  };  // class VNode
class VPQueue
  {  // the Queue itself
  VNode *head;
public:
  void Insert(void *d);
  void *Get();
  virtual int Greater(void *a, void *b)
    { return 0; }
  virtual void Destroy(void *d)
    { delete d; }
  void Clear();
  VPQueue()     { head = 0; }
  ~VPQueue()    { Clear(); }
  };  // class VPQueue
//////////////////////////////////////
//          VPQUEUE.CPP
#include "vpqueue.h"
void VPQueue::Insert(void *d)
  {  // insert in sorted order
  if (!head || Greater(d, head->data))
    {  // first item
    head = new VNode(d,head);
    return;
    }
  VNode *n = head;
  while (n->next &&
      !Greater(d, n->next->data))
    n = n->next;
  n->next = new VNode(d,n->next);
  }  // VPQueue::Insert()
void *VPQueue::Get()
  {  // get highest priority item
  if (!head) return 0;
  void *ret = head->data;
  VNode *del = head;
  head = head->next;
  delete del;
  return ret;
  }  // VPQueue::Get()
void VPQueue::Clear()
  {  // clear entire queue
  while (head)
    {
    VNode *n = head;
    head = head->next;
    Destroy(n->data);
    delete n;
    }
  }  // VPQueue::Clear()
//////////////////////////////////////
//            VPQTEST.CPP
#include <iostream.h>
#include "vpqueue.h"
class intVPQueue : public VPQueue
  { // a priority queue of ints
public:
  void Insert(int *d)
    { VPQueue::Insert(d); }
  int *Get()
    { return (int *) VPQueue::Get(); }
  int Greater(void *a, void *b)
    { return *((int *) a) > *((int *) b); }
  void Destroy(void *d)
    { delete (int *) d; }
  };  // class intVPQueue
int main()
{
intVPQueue test;
test.Insert(new int(2));
test.Insert(new int(7));
test.Insert(new int(5));
test.Insert(new int(1));
int *p = test.Get();
while (p)
  {  // get and print all
  cout << *p << endl;
  delete p;
  p = test.Get();
  }
return 0;
}  // main()
```

Figure 1 - PQueue as a void container*

The main advantage of the `void*` method is that it is the easiest for a C programmer to understand. C jocks live for the reckless abandon of a 'pointer to anything', and the associated type-casts that go along with it. More seriously, while '`Object*`' containers can only contain objects derived from a specific base class (`Object`), a `void*` container can contain any type of object.

```
//////////////////////////////////////
//              OPQUEUE.H
//////////////////////////////////////
class Object
  {  // base class for items on Queue
public:
  virtual ~Object() {}
  virtual int Greater(Object *d)
    { return 0; }
  };  // class Object
class ONode
  {  // one node on the Queue
  friend class OPQueue;
  Object *data;
  ONode *next;
  ONode(Object *d, ONode *n)
    { data = d; next = n; }
  };  // class ONode
class OPQueue
  {
  ONode *head;
public:
  void Insert(Object *d);
  Object *Get();
  void Clear();
  OPQueue()     { head = 0; }
  ~OPQueue()    { Clear(); }
  };  // class OPQueue
//////////////////////////////////////
//          OPQUEUE.CPP
//////////////////////////////////////
#include "opqueue.h"
void OPQueue::Insert(Object *d)
  {  // insert in sorted order
  if (!head || d->Greater(head->data) )
    {  // first item
    head = new ONode(d,head);
    return;
    }
  ONode *n = head;
  while (n->next &&
      !d->Greater(n->next->data) )
    n = n->next;
  n->next = new ONode(d,n->next);
  }  // OPQueue::Insert()
Object *OPQueue::Get()
  {  // get highest priority item
  if (!head) return 0;
  Object *ret = head->data;
  ONode *del = head;
  head = head->next;
  delete del;
  return ret;
  }  // OPQueue::Get()
void OPQueue::Clear()
  {  // clear entire queue
  while (head)
    {
    ONode *n = head;
    head = head->next;
    delete n->data;
    delete n;
    }
  }  // OPQueue::Clear()
//////////////////////////////////////
//          OPQTEST.CPP
#include <iostream.h>
#include "opqueue.h"
class Integer : public Object
  {
public:
  int val;
  Integer(int v) { val = v; }
  int Greater(Object *d)
    { return val > ((Integer*) d)->val; }
  };  // class Integer
int main()
{
OPQueue test;
test.Insert(new Integer(2));
test.Insert(new Integer(7));
test.Insert(new Integer(5));
test.Insert(new Integer(1));
Integer *p = (Integer*) test.Get();
while (p)
  {  // get and print all
  cout << p->val << endl;
  delete p;
  p = (Integer*) test.Get();
  }
return 0;
}  // main()
```

Figure 2 - PQueue as an Object container*

```
//////////////////////////////////////
//              TPQUEUE.H
//////////////////////////////////////
template <class T> class Node
  {  // one node on the Queue
  friend class PQueue<T>;
  T *data;
  Node<T> *next;
  Node(T *d, Node *n)
    { data = d; next = n; }
  };  // class Node
template <class T> class PQueue
  {
  Node<T> *head;
public:
  void Insert(T *d);
  T *Get();
  void Clear();
  PQueue()     { head = 0; }
  ~PQueue()    { Clear(); }
  };  // class PQueue
template <class T>
 void PQueue<T>::Insert(T *d)
  {  // insert in sorted order
  if (!head || (*d > *(head->data)))
    {  // first item
    head = new Node<T>(d,head);
    return;
    }
  Node<T> *n = head;
  while ( n->next &&
      !(*d > *(n->next->data)))
    n = n->next;
  n->next = new Node<T>(d,n->next);
  };  // PQueue<T>::Insert()
template <class T> T *PQueue<T>::Get()
  {  // get highest priority item
  if (!head) return 0;
  T *ret = head->data;
  Node<T> *del = head;
  head = head->next;
  delete del;
  return ret;
  };  // PQueue<T>::Get()
template <class T>
 void PQueue<T>::Clear()
  {  // clear entire queue
  while (head)
    {
    Node<T> *n = head;
    head = head->next;
    delete n->data;
    delete n;
    }
  };  // PQueue<T>::Clear()
//////////////////////////////////////
//            TPQTEST.CPP
#include <iostream.h>
#include "tpqueue.h"
int main()
{
PQueue<int> test;
test.Insert(new int(2));
test.Insert(new int(7));
test.Insert(new int(5));
test.Insert(new int(1));
int *p = test.Get();
while (p)
  {  // get and print all
  cout << *p << endl;
  delete p;
  p = test.Get();
  }
return 0;
}  // main()
```

Figure 3 - PQueue as a template container

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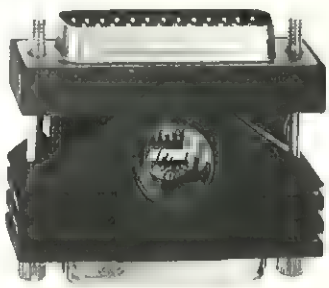

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CIRCLE NO. 942

A `void*` container has some problems that just can't be overcome, though. The most obvious is that you must derive a new container class for each type of object you want to 'contain'.

This isn't very involved for a class like `VPQueue` (see VPQTEST.CPP in Figure 1) but becomes quite tedious for more complex classes like DList which have more member functions. Of course, you can follow the lead of Stroustrup (and Zortech) in using GENERIC.H macros to shorten derived class definitions to a single line, but I consider this blatant use of macros to be error prone, ugly, and in terribly low taste. Weren't inline functions created to reduce use of the preprocessor?

More importantly, the fact that the `Greater()` and `Destroy()` functions are part of `VPQueue`, and not of the object itself, means that all objects on the queue must use the same functions. This in turn implies that `void*` containers must be homogeneous - although different `VPQueues` can contain different types of objects, all objects on any one `VPQueue` must be of the same type. To make sure that nobody mistakenly tries to put a different type of object on a `VPQueue`, its descendants should redefine `Insert()`, as in `intVPQueue`, to specify the type of its argument.

The above problems point to a conceptual flaw in `void*` containers. A container should not need to (indeed, should not) know how to compare two objects it contains, nor should it know how to destroy those objects. That kind of detail should be known only by the objects themselves, otherwise there is a serious hole in the objects' encapsulation. Noting this flaw leads us to method two for designing containers.

Object* Containers

`Object*` containers remove the object comparison and destruction functions (and other possible functions not needed in this example) from the container class and put them with the object, where they rightfully belong. Figure 2 shows the `OPQueue` class which is implemented using the `Object*` method. The `Objects` themselves are pointed to by the data member of `ONode`.

You'll notice that `Greater()` is now a virtual member of `Object`. `Destroy()` no longer exists, as that duty is handled by a virtual destructor for `Objects`. If `Object`'s destructor is declared `virtual`, the destructors of its descendants are automatically made virtual, resulting in the proper destructor being called by `delete`, even if `delete` is given an `Object*` (instead of a pointer to the actual class of the object). The implementation of other functions is nearly identical to `VPQueue`.

Now the same type of container can be used to hold different types of object as long as they are all derived from `Object`. Even heterogeneous containers are possible - a single container can hold objects of different types (as long as the `Greater()` function knows how to compare objects of differing types). Of course, in return for this, we must derive a new class for each kind of object we want to store.

You'll notice, though, that in the example I must do a type-cast each time I call `Get()`. This is necessary because `Get()` returns an `Object*`, while we know that the `OPQueue` contains `Integers`. As `val` is declared in `Integer`, we can't access it through an `Object*`, we have to cast the `Object*` to `Integer*` first. This problem could also be solved in much the same way it was solved in `VPQueue` - by deriving a 'wrapper class' which did the type casting for us.

Like `void*` containers, `Object*` containers can never contain the data itself, just a pointer to the data. This is fine for large data items, but creates unproportionally large amounts of overhead when the container will be used just for `ints` or `chars`.

Template Containers

Figure 3 is an example of a Container designed using C++'s new 'template' feature. Where the previous two methods created functions for manipulating the objects in the container and used that same code for any type of object, templates merely create a 'stencil' of what the functions should look like. No code is generated until a container is declared (as '`PQueue<int> test`' in the example), when the actual class (`int` in our example) is substituted for the template class (`T`) and the container and its members are emitted. This is in many ways the same trick performed by GENERIC.H and the macro preprocessor, but cleaner and easier to understand.

Our previous problems of comparison and destruction are solved by the mere fact that when a `PQueue` is declared, new code is generated which creates exactly the correct comparison and destruction calls for the objects in question. Note that in order for `PQueue<xxx>` to compile correctly, the class `xxx` must have an `operator>()` function defined.

New code being generated for each different object type has good and bad implications. On the good side, the restriction that the data in containers always be the same size is lifted, meaning that you can create container templates which store objects rather than pointers to objects. This of course leads to faster executing code and more efficient use of data segment space. On the bad side, while source code remains short, .EXE size suffers.

Normal classes can have just the class definition in their header file, and their member functions compiled separately, but template class header files must contain the class definition AND the member functions. This allows the compiler to generate member functions from the templates when needed. Longer header files, of course, lead to longer compile times. I noticed something on the order of .01 second difference between the template version of my example and the other versions.

You can of course create heterogeneous containers based on template containers. Just make a base class like `Object`, and declare, for example, a `PQueue<Object>`. As descendants of `Object` will be different sizes, you must again stick to containers of `Object*`.

Which is Best?

This question can be answered with another question: Which do you have? Using an already existing container class is always easier than creating a new one. Keep in mind my warning about the Zortech Tools Library, and watch for similar problems in other `void*` container classes. If you want to make your own containers though...

Keeping in mind that templates can be used to create `Object*` or `void*` containers, and `void*` containers can be used to create `Object*` containers (with some acrobatics), it seems that templates are the way to go - even if you make an `Object*` container, do it with templates, that way you'll be able to reuse it for something else some day.

If your compiler doesn't have template capabilities, then use `Object*` methods. `void*` containers are merely a kludge for those who aren't yet totally comfortable with OOP. They may work, but they'll lead you down the wrong road.

EXE

Laine can be reached via the PC Tech BBS at (0101-612-345-4656, evenings, US time) or by post at: Bilkent University, Lojmanlari 3/9, 06533 Bilkent / Ankara, TURKEY.

Background tasks in Clipper

...or taking the 'wait' out of 'wait states'. Guy Smith shows how you can do-it-yourself.

Every now and again one of life's trivial details comes to the surface and stays long enough for a major revelation to occur. Times like these can be acutely embarrassing as you realise that the revelation is so simple and powerful there is no ready reason why it should have eluded you so long.

This text presents one of these simple ideas. The concept is simple and fundamental but a little thought can show how powerful it can be. The idea may well change your approach to programming and your attitude to Clipper.

The Idea

The idea is simply this : All our applications use many wait states. These wait states need not go to waste; they can be used for our own purposes.

The simplest of wait states is `Inkey(<nSecs>)` and this is the one we will attack. This wait state occurs in two of the most common wait states in an application: the get system and browsing. We will return to the other wait states later.

We need to replace this wait state, `Inkey(<nSecs>)`, with one under our own control, `BTskInkey(<nSecs>)`. The easiest solution here is to copy STD.CH to MYSTD.CH and add this line:

```
#translate Inkey(<nSecs>) =>
 BTskInkey(<nSecs>)
```

set the CLIPPERCMD environment variable:

```
SET CLIPPERCMD=/UMYSTD.CH
```

then recompile all PRGs. All references to `Inkey()` will change to `BTskInkey()`.

BTskInkey()

`BTskInkey()` fulfils the same purpose as `Inkey()` with the addition that it also processes background tasks.

Background tasks are tasks which can occur during a wait state. Before providing a few examples let's discuss exactly how these tasks will be managed and processed.

`BTskInkey()` counts down the number of seconds (or forever if seconds is 0) not by using `Inkey(<nSecs>)` but by marking the start time and counting down from there. See Figure 1.

In this way control is retained by `BTskInkey()`. Into the loop we simply need to add a function to process the background tasks, `BTskEval()`.

Managing tasks

BTSK, shown in Figure 2, contains all the functions which are needed to manage the background tasks. The external static `aTasks` is an array where each element is an array describing a background task. The background task consists of a task handle and the task code block. It is important to note that the task list is not a stack as tasks can complete at different times and may, therefore, remove themselves from the task list in a seemingly random order. Hence the task handle returned is a uniquely generated number identifying the task rather than the element number of the array as the element number is not a constant.

The `BTskInkey()` function listed in Figure 2 includes a number of simple refinements:

The number of the last task executed is saved in a static variable so that the next wait state starts where the last finished and an even distribution is maintained.

If `BTskInkey()` runs out of tasks to execute it calls a genuine `Inkey()` to enable Clipper's VMM to perform garbage collection.

If the return result of the task is a number it is taken as a keypress and returned as the actual key pressed. Thus key filtering and substitution can take place.

`BTskInkey()` passes a parameter to each task indicating how many times it has been called by the current wait state. This information is required by some background tasks.

Timeout

The most simple of background tasks watch for a timeout situation. Many programmers will already have modified GETSYS.PRG with this aim but such changes are necessarily limited to `GET/READ` and must be dutifully made to each reader function. Often it is useful to operate an application-wide timeout and either re-demand the user's password or log the user right out of the system.

The two functions required for this are shown in Figure 3. The functions shown allow for just a single timeout but it would be relatively easy to modify them for more than one timeout task.

The `BTOut()` function maintains a start point using a static variable which is initialised the first time it is called for each wait state (ie when `nCalls` is 1). If the difference between the start point and the current time is greater than the timeout seconds a timeout occurs.

Clock

The number of uses for a background task are numerable and varied. Maintaining an on-screen clock would be simplicity itself. All that need be done is to add a task which printed `TIME()` at a given location on the screen. However the clock would only be updated during wait states so it would give better results if just hours and minutes and no seconds were shown. A simple variation on this idea would be a stopwatch which displayed time elapsed.

Perhaps the most dramatic and simple uses for a timeout would be a browse refresh or

```
function BTskInkey(nSecs)
local nStartSecs:=seconds()
local nKey:=inkey()
do while
(nSecs==0 .or. seconds()-nStartSecs<=nSecs)
.and. nKey==0
   ...
   ...
   ...
  nKey:=inkey()
enddo
return(nKey)
```

Figure 1 - Inkey() written in Clipper

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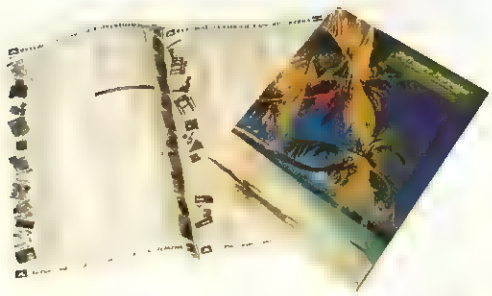

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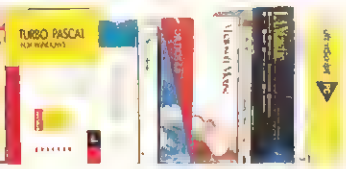

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READ refresh. A background task could be set which, after every 30 seconds or so, sent the `refreshAll()` message to a given `TBrowse` object. Alternatively the background task could refresh a READ every 30 seconds or so, or refresh the screen only when the data is changed by another user.

Keyboard scripts

A task can effectively control the keyboard. On this basis two simple functions, `KbdRecord()` and `KbdPlayBack()`, allow the recording and playback of keyboard macros including keystrokes which are outside the capabilities of the KEYBOARD command. A call to `KbdRecord()` must be included in `BTskInkey()` immediately before the `Return` statement to enable keystrokes to be recorded. `KbdRecord()` and `KbdPlayBack()` are shown in Figure 4. A simple variation on the keyboard tasks and timeout tasks would be to lock the keyboard after a period of inactivity.

A more involved variation on the keyboard tasks would be to provide an interactive tutorial or demo script which actually ran the program concerned and taught or demonstrated in a live environment.

Popup calendars and popup calculators could be set to create playback scripts in order to paste dates or numbers into the application proper.

Messaging

Inter-terminal messaging is a great tool for easing user frustration and alienation. A function, say `ITMInstall()`, installs a message detector, `ITMWatchDog()`, as a background task and opens a shared table of messages, ITM.DBF.

Each new message is given a unique message number, a *From* user ID and a *To* user ID. The *To* user ID could be a specific user or *ALL* to broadcast a message to all users.

The `ITMWatchDog()` function needs only to softseek for a message number greater than the last message read which is addressed to the user or to *ALL*. If such a message is found `ITMWatchDog()` sounds the bell and displays a message. In this way the mail need not interfere with the running of the application.

A hot key is set to `ITMManager()` which would allow the user to create, read, reread and delete mail.

Other applications

There are several simple variations on the messaging theme. An alarm clock background task is an obvious variation. How-

```
* BTSK.PRG
static aTasks:={}

function BTskInkey(nSecs)
* Purpose :- to operate almost identically to the standard
* Clipper INKEY() function with the exception that SET KEYs are
* processed properly and background tasks are processed

local bkeyblock,nKey
do while .t.
  nKey:=iif(valtype(nSecs)=='N' .and. nSecs>=0 ,BInkey(nSecs),
inkey())
  if (bkeyblock:=setkey(nKey))==NIL
    exit
  else
    eval(bKeyBlock, procname(2), procline(2), '')
  endif
enddo
return(nKey)
*
* eofunc BTskInkey()
*

static function BInkey(nSecs)
* Purpose :- provide an inkey for a number of seconds
* 'nBTsk' is the task number
static nBTsk:=1
local nKey:=inkey()
local nStartSecs:=seconds()
local nCalls:=0
local nStartingTask:=nBTsk
local xResult

do while (nSecs==0 .or. seconds()-nStartSecs<=nSecs) .and. nKey==0
  if BTskCount()>0
    * there are background tasks to be processed
    if nBTsk > BTskCount()
      * go back to the beginning of the list
      nBTsk:=1
    endif

    if nBTsk==nStartingTask
      * increment the number of times the task has been called
      * within the current wait state
      nCalls++
    endif

    * evaluate the background task and increment the task pointer
    xResult:=BTskEval(BTskNum2Handle(nBTsk++), nCalls)
    if valtype(xResult)=='N'
      * use the subtituted value as the key pressed
      nKey:=xResult
      exit
    else
      nKey:=inkey()
    endif

  else
    * there are no background tasks so give Clipper's VMM a chance
    nKey:=inkey(nSecs)

  endif

enddo
return(nKey)
*
* eofunc BInkey()
*
```

```
function BTskCount()
* Purpose :- to return the number of tasks in the task list

return(len(aTasks))
*
* eofunc BTskCount()
*

function BTskNew(bTask)
* Purpose :- to add a new task to the task list and return
* the task handle
* 'nTskHandle' is a unique handle by which a task is known

static nTskHandle:=0
if valtype(bTask)=='B'
  aadd(aTasks, {++nTskHandle, bTask})
endif
return(nTskHandle)
*
* eofunc BTskNew()
*

function BTskNum2Handle(nElem)
* Purpose :- to return the task handle at the position 'nElem'
local nHandle:=0
if valtype(nElem)=='N' .and. nElem>0 .and. nElem<=len(aTasks)
  nHandle:=aTasks[nElem, 1]
endif
return(nHandle)
*
* eofunc BTskNum2Handle()
*

function BTskHandle2Num(nHandle)
* Purpose :- to return position of the task handle
local nElem:=0
if valtype(nHandle)=='N'
  nElem:=ascan(aTasks, {|aTask| aTask[1]==nHandle}) endif
return(nElem)
*
* eofunc BTskHandle2Num()
*

function BTskEval(nHandle, nCalls)
* Purpose :- to evaluate the task identified by nHandle
local nElem, xResult

if (nElem:=BTskHandle2Num(nHandle))>0
  * nHandle is valid
  xResult:=eval(aTasks[nElem, 2], nCalls)
endif
return(xResult)
*
* eofunc BTskEval()
*

function BTskDel(nHandle)
* Purpose :- to remove a task from the task list
local nElem

if (nElem:=BTskHandle2Num(nHandle))>0
  * nHandle is valid
  aDel(aTasks, nElem)
  aSize(aTasks, len(aTasks)-1)
endif
return(NIL)
*
* eofunc BTskDel()
*
```

Figure 2 - BTSK.PRG (Background Task Management)

ever, the alarm clock need not be limited to a simple message. By using a code block instead of a character string for the message the application can be made to perform certain tasks at specific times of the day.

The messaging system need not be restricted to sending messages between the users. Inter-application messaging where the applications themselves generate messages to send between themselves of which the user is unaware and requires no knowledge or action is quite feasible. For example if a lock failed the application requiring the lock could broadcast a message to all other workstations asking who owns the lock.

Taking this idea a step further it follows that if the application can send itself internal messages telling it to do something (ie timed tasks) then a system controller could send inter-terminal messages to tell specific or all workstations to perform certain tasks. Thus remote logoff and, indeed, remote control of any nature is possible right down to the control of the keyboard.

```
function BTOutNew(nSecs, bTimeout)
* Purpose :- to install a new timeout
*
return (BTskNew({|nCalls|
  BTOut(nCalls, nSecs, bTimeout)}))

function BTOut(nCalls, nSecs, bTimeout)
* Purpose :- to look for a
* timeout situation

static nStartSecs
local nKey
do case
   case nCalls==1
     * this is the first time this
     * function has been called for the
     * current wait state so initialise
     * the starting point
     nStartSecs:=seconds()
   case seconds() nStartSecs>nSecs
     * timed out
     if valtype(bTimeout)=='B'
       nKey:=eval(bTimeout)
     endif
     if .not. valtype(nKey)=='N'
       nKey:=0
     endif
endcase
return(nKey)
```

Figure 3 - Timeout Background Task

Problems

As I mentioned at the beginning of the article, `Inkey()` on which the whole idea is based is not the only wait state. Other wait states for which we do not have control include: `MemoEdit()`, `aChoice()`, `Alert()` and `@ PROMPT / MENU TO`. We will ignore `WAIT` and `dbEdit()`.

The most obvious solution is to rewrite each of these in Clipper solely for the benefit of using our own `Inkey()` function. For `Alert()` this is not so difficult but it is not practical for `MemoEdit()` without the aid of a memo class library.

The solution for `MemoEdit()` is not aesthetically pleasing. It involves forcing the wait state into the UDF called by `Memo-`

```
#define KBD_BEGINRECORD         1
#define KBD_ENDRECORD           2
#define K_SEQUENCE_TERMINATOR  K_CTRL_F1
static aKeys:={}
function KbdRecord(nKey, nNewMode)
static nMode:=KBD_ENDRECORD
if nKey==K_SEQUENCE_TERMINATOR
  * user terminated record sequence
  * using Ctrl-F1
  nNewMode:=KBD_ENDRECORD
endif
if valtype(nNewMode)=='N'
  * new mode is being set
  nMode:=nNewMode
  if nMode==KBD_BEGINRECORD
    aKeys:={}
  endif
endif
if nMode==KBD_BEGINRECORD
  aadd(aKeys, nKey)
endif
return(aKeys)
function KbdPlayBack()
local nKey
if len(aKeys)>0
  nKey:=aTail(aKeys)
  aSize(aKeys, len(aKeys)-1)
endif
return(nKey)
```

Figure 4 - Keyboard Record and Playback

`Edit()`. The UDF would contain a wait state which would supply keys to `MemoEdit()` and stuff an additional keystroke into the keyboard buffer in order to return control to the UDF. Not an elegant solution but it is a solution nonetheless.

An additional problem is the use of `LastKey()`. Many of the tasks outlined in this article rely on being able to substitute a keyboard value (timeout, keyboard scripts, remote keyboard control). `LastKey()` returns the last key physically pressed which may or may not be the last keystroke supplied to the application.

What is required is a replacement for `LastKey()`, `BTskLastKey()`, which can be integrated in the same way as for `Inkey()`. `BTskLastKey()` simply returns the last key supplied by `BTskInkey()`. The code for `BTskLastKey()` is left to the reader.

```
function BTVMMNew()
* Purpose :- to install a garbage
* collection background task
return(BTskNew({|nCalls| BTVMM(nCalls)}))
function BTVMM(nCalls)
* Purpose :- to perform garbage collection
* at the beginning of each wait state
if nCalls==1
  memory(-1)
endif
return(NIL)
```

Figure 5 - Memory Garbage Collection

The last problem concerns Clipper's VMM. As a genuine wait state is virtually never entered into, VMM's garbage collection will only be performed on an 'as needed' basis thereby slowing down the application. A simple solution to this would be to set up a background task which mirrors Clipper's normal use of VMM in `Inkey(0)`. To do this we need to know that one of the undocumented parameters to the `Memory()` function can be -1. `Memory(-1)` performs garbage collection immediately. Thus the background task in Figure 5 performs garbage collection each time a wait state is started.

Conclusion

Many of the techniques described here are available from networking libraries, other add-ons and additional software. However, rather than being a poor man's substitute this method has advantages beyond other solutions. The solution is generic and will work on any network, and most importantly, it is integrated into the application. The approach is analogous to the arguments for using classes and methods over variables and functions.

Of course, in the long run Nantucket will provide more elegant solutions to many of these problems when it includes its event handler. Unfortunately it is not possible to create a fully functional event handler using Clipper 5.01 and until then this solution is simple to implement and provides many features previously described as impossible or too difficult to implement.

EXE

Guy Smith is a freelance writer and has developed in Clipper, amongst others, since Clipper Winter '85. He is the author of the Capella Library, an application development library for Clipper 5. Guy can be contacted on CompuServe at 100014,1724 or on CIX as `smithg`.

The code presented in this article plus a full implementation of a background print manager is available on disk. Send a blank formatted floppy disk to the Editor, following the instructions given on Page 1, column 1. Mark your envelopes 'BTSK'.

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Terminals

This month Peter Collinson clears the muddy waters of UNIX terminal I/O.

In October of last year, *.EXE* contained an article by Ben Thompson about his struggles with the UNIX terminal interface and how he overcame them. Ever since then, I have wanted to complete the picture, as it were, to sketch in how things work and why this seemingly over-complex structure is in place.

Life is easier in a single-user system. There is only one keyboard to deal with at any one time. When a program gets a character from the keyboard, that's all the CPU is doing. It can happily sit in a tight loop polling away while it waits for the user to put down that cup of coffee and do something. When the program finally has a character and wants to echo it back to the user then there is only one place to put it, only one screen.

There were small single-user systems around 25 years ago when UNIX was created. Machines then were orders of magnitude more expensive. The fundamental ideas of time sharing sprang from the desire of people to use the expensive hardware to its fullest. It's perhaps curious how these multi-processing systems have become the cornerstone of many people's single-user workstation environment.

Multi-user systems

The designers of UNIX were making a multi-user, multi-processing system. There would be more than one terminal attached to the machine so programs that talk to the terminal must not have particular hardware addresses burnt in. All terminal operations must take place independent from the actual device that the user is using.

The aim is to provide complete device-independent operation to all programs. The model of device-independence that UNIX uses is the byte stream. Many UNIX programs read streams of data on their input channels and expect to generate streams for output. We want all these programs not to have to do anything special when talking to a terminal, or any other device.

This work is done by the device driver. User processes will issue `read` or `write` system calls to move data in and out of the kernel. Because the file descriptor used in these system calls is a device, eventually the process will find itself running the code in the device driver.

If you alter terminal settings, you must never rely on the shell resetting things after you

You should think of the device driver as having two halves. The 'top level' provides an interface to the processes, moving data between the kernel and the process address space. The 'bottom level' provides an interface to the device. It moves data between the device and the 'top level' in the kernel. It is generally interrupt driven.

The top and bottom levels are two asynchronous code paths or threads of control. The top level is called directly by the user process. When the user process issues the appropriate I/O system calls, the top level becomes part of the user's code path, part of his thread. The bottom level is called by the interrupt system on the machine and runs independent from any user process. The two levels communicate by a data buffer.

The top level will *block* when it has nothing to do. A process that is writing will block when there is not enough space in the output buffers to put yet more characters from the user's address space. Once blocked, the top level code will not restart until the kernel issues a wakeup call.

There is a system load imposed by the context switch when we stop and start processes. We want each section of the system to do as much as it can before giving up the processor. We want the top level code to move as much data as it can between the user process and the kernel. It can then be put to sleep for some lengthy period of time while the kernel gets on with shipping data to or from the device. When it has done, the kernel will wake up the top level to move more data.

Terminal reads

A terminal keyboard driver that is reading characters from the user in the normal mode (sometimes called *cooked* mode) operates in units of lines. It will store the user's data until *return* is hit. Only then will a blocked top level be woken to move the lines from the kernel internal buffers into the process address space. To minimise top level restart, the kernel takes on the load of keeping the user happy by echoing any input and doing any line editing that may be needed.

To see this in practice, let's follow through the sequence of events that happen when we read characters from the terminal. We start at the point where the user process issues a `read` system call that will eventually call the device interface.

There may be characters ready in the buffer for that terminal. If there are, they are moved into the process and that's that. The independent bottom half of the device driver can run at any time. UNIX permits type-ahead, characters can be entered when there is no process available to read them. The data lurks in the terminal buffer until some process comes along. If the buffers get too full, then inbound characters are simply discarded.

If there are no characters available in the buffers for that terminal when the process issues its `read` system call, then nothing can be done. The process is marked as waiting for input from the terminal and blocks until the user types something.

An interrupt will be raised when the keyboard is struck. The kernel catches the interrupt and dives into the device driver bottom level. This reads the character from the keyboard and resets things so that the next input character will set off another interrupt.

The kernel is holding a character and has some choices depending on how the interface is configured. In the normal case, the action that is taken depends on the character that has been entered. Most characters are simply placed in a buffer and retained in the kernel until a *return* is entered. They are also put onto the output queue so they find their way to the screen as a character echo.

Other characters are used to permit the user to interact with controlling functions within the terminal driver. The character could be one concerned with editing the input line.

The character could be one of those that results in a signal being sent to the processes that are using the terminal. The kernel delves into a table of user settable characters to see if the character should cause a signal eg ^C. Some systems permit the user process to request that a signal is sent on the receipt of any character. If any of these signals is to be sent, then the kernel will post the signal to the appropriate processes.

When the user strikes *return*, it tells the kernel that the user wants to send any stored characters to the top level. What happens here is system dependent. Some systems will move character buffers up through layers of code. Some early systems were worried about the time spent at interrupt level and did not edit the data buffer as the user deleted characters. Instead a marker was placed in the buffer and the processing was done at the top level. The 'real' data was created by making a 'canonical' buffer.

Whatever the mechanism, the top level is woken up and moves the data into the address space of the process. The `read` system call will return with the number of characters that were moved. All programmers are used to dealing with this. All programs are written to expect that `read` may return less than the requested number of bytes.

Controlling the interface

Normal mode of working may not be what the user process wants. The complexity of the terminal device driver springs from the desire to allow the process to select only the parts of the kernel processing that it needs. These days in UNIX systems, this is done by `ioctl` calls. Original UNIX systems used the `stty` system call to set information and the `gtty` call to retrieve it. One original name is now seen as a command that gets and sets terminal information: `stty`.

The aim is to provide complete device-independent operation to all programs

POSIX has defined a new set of routines that are used to get and set terminal information. These routines move a C structure called `termios` in and out of the kernel. Setting bits and values in the structure will alter the way that the interface works. The structure is a clone of the System V way of doing things and will look a little like:

```
struct termios {
    unsigned short c_iflag;
    unsigned short c_oflag;
    unsigned short c_cflag;
    unsigned short c_lflag;
    unsigned char c_cc[NCCS];
};
```

Things may vary on your machine. The variable `c_iflag` has bits that control basic actions on input. The variable `c_oflag` controls output translations and character delays. The hardware control of the terminal is determined by `c_cflag`. This is where the baud rate is set and parity selected.

In older systems, a single bit in the terminal control structure was used to show that the terminal was to work in raw mode.

The more modern structure splits the control of the various aspects of processing into many more pieces. This means that you must use a combination of bits to emulate the old raw mode.

Forwarding from the bottom to the top level is controllable too. First you turn off any processing of editing characters by clearing the ICANON bit in the `c_lmode` word. Then two bytes in the `c_cc` vector become variables that control top level wakeup. On my Sun, the variables are `c_cc[VMIN]` and `c_cc[VTIME]`. Your implementation might be different and I call these TIME and MIN in the following discussion. The MIN variable represents the minimum number of characters that should be received before the wakeup is actioned. The TIME variable is a timer of 0.10 seconds that is used to timeout bursty or short transmissions.

Setting MIN to 1 and TIME to zero is the the simplest use, forcing the forwarding of every received character to the user process. Visual editors use this in combination with other control bits to ensure that they see every keystroke that the user makes.

Changing the settings

It's easy to write programs that change the basic settings on the interface. Control of the terminal is one of the few pieces of UNIX state that is external to the process. If your program changes the settings, then it must be public spirited and reset them when it is done. Also, you should catch signals like Ctrl-C so that you can reset the terminal on forced exit.

Be careful when you start messing with the terminal, you can easily get the interface into a state where you cannot talk to the machine if your program dies unexpectedly. You may not be able to log off to repair things. Sometimes you must go to another terminal and issue `kill` commands to force your shell to die (use `kill -9`).

Turning echo off goes something like:

```
struct termios t_o, t_n;
..
..
/* keep old values for */
/* reset in signal handler */
   ioctl(1, TCGETA, &t_o);
   t_n = t_o;
   t_n.c_lflag &= ~ECHO;
   ioctl(1, TCSETA, &t_n);
```

Echo is now off and if your program crashes you will have to type

```
$ stty echo
```

to reset things.

Setting input raw mode is no harder:

```
/* keep old values for */
/* reset in signal handler */
   ioctl(1, TCGETA, &t_o);
   t_n = t_o;
/* leave top bit alone */
   t_n.c_iflag &= ~ISTRIP;
/* ensure 8 bit processing */
   t_n.c_cflag |= CS8;
/* turn off signal handling */
   t_n.c_lflag &= ~ISIG;
/* turn off canonical mode */
  t_n.c_lflag &= ~ICANON;
/* turn off echo */
  t_n.c_lflag &= ~ECHO;
/* forward on every char */
  t_n.c_cc[VTIME] = 0;
  t_n.c_cc[VMIN] = 1;
/* go for it */
   ioctl(1, TCSETA, &t_n);
```

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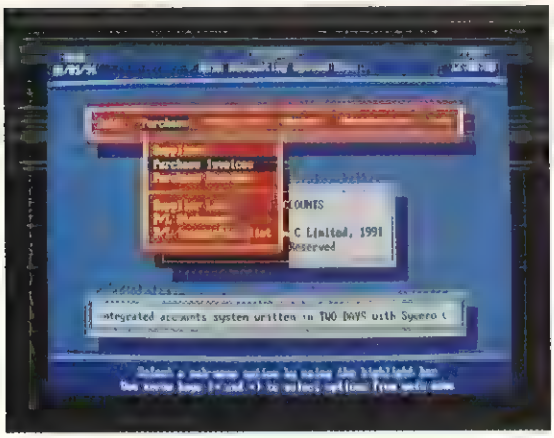

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If you do all this and your program crashes then you might be able to reset things by typing:

```
% stty sane
```

Finally on this topic, beware that some shells reset the terminal interface when they get hold of it. However, if you do alter terminal settings you must never rely on the shell resetting things after you. Some shells will not.

Writing

This is much less complicated. A user process will use the `write` system call to move characters from its address space into the kernel. The system call will return when all the characters have been transferred. It does not wait until all the characters have been output.

The process will block if the kernel has insufficient resources to take the data.

The only complication with output is the support of per character delays so some types of hardware can function correctly. The `c_oflag` word in the `termios` structure controls character delays. You rarely touch this in programs. It tends to be established by the user at login time.

Multi-processing

On a multi-processing system, we do have to worry a little about what happens when more than one process attempts to write or read from the same terminal.

Several user processes can be using the top level in parallel. They will be executing the same code but running on their own stacks, so each process is running a separate instance of the top level routines. All these data sources will be adding characters to the data buffer that interfaces between the top and bottom levels. The bottom level ships the characters to the output device. The effect is a jumble of output from several different sources.

Some systems help by allowing the user to specify that background processes will be blocked if they attempt to talk to the terminal. This is a 'BSD-ism' and was added as part of job control.

It's easy to set up two processes reading from the terminal. This has little semantic value and the effect is hard to predict. In cooked mode, each process is likely to get alternate lines from the user. This can result in some confusion so it's a good idea to avoid this.

Further reading

See the relevant manual pages on your system: `stty(1)` and `termio(4)` are good sources. Poke about the include files on `/usr/include`, look at `termios.h` and `termio.h`. For more discursive material see a System III or System V book: I am using *UNIX System Programming* by Keith Haviland and Ben Salama, published by Addison Wesley. The POSIX standard P1003.1:1990, now published as ISO/IEC 9945-1 is also a source on this material.

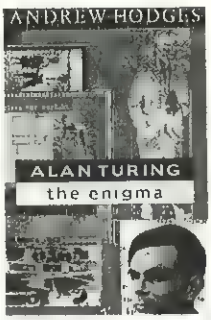
EXE

Peter Collinson is a freelance consultant specialising in UNIX. He can be reached electronically as `pc@hillside.co.uk` *(although your mailer might be happier to put the address the other way round) or by phone on 0227 761824.*

Books

This month, an autobiography of a pioneer.

Of machines, questions and breasts



'Turing' is a name which conjures up a vague sensation of awe and respect, yet I believe many of our profession know little about the man, his life and his work. The new edition of Andrew Hodges brilliant biography *Alan Turing: The Enigma* gives me a chance to recommend a book which is not only an excellent read, but also gives one an unusual perspective on the business of writing programs.

Turing's story is a fascinating one. Born in 1912 to a middle-class 'empire-building' family (his father was in the Indian Civil Service), most of Alan Turing's early years were spent in England with friends of the family and at various boarding schools, culminating with Sherborne, a league division two public school situated in East Dorset. Here he suffered considerably under a regime that despised maths and 'stinks' and individualism, and favoured 'footer'-playing conformists. Despite early mathematical efforts, which included the feat of finding a series for $tan\text{-}1\ x$ without having learnt any calculus, Turing was nearly expelled from Sherborne midway through his career for poor work in English and Latin. In the event he was saved only by a chance change in headmaster.

Notwithstanding these struggles, Turing obtained a scholarship to King's College, Cambridge in 1931. At Cambridge he prospered; his proof of the Central Limit Theorem (yes you do - it's the one which allows the Normal curve to be applied to just about any random variable) was rewarded by an election to Fellowship in early 1935. In fact, the result had already been proved in 1922 by another mathematician - Turing had absent-mindedly neglected to check to see if the work had already been done.

It was now that Turing did his most famous mathematical work. In 1928 the great mathematician David ('matrix') Hilbert had posed a number of questions. The third of these was: was mathematics 'decidable'?, by which he meant 'did there exist a definite method which could, in principle, be applied to any assertion, and which was guaranteed to produce a correct decision as to whether the assertion was true?' Turing applied himself to this question and, in order to help in the abstraction of the problem, conceived his famous Turing machine.

The Turing machine is well-described elsewhere; essentially it is an imaginary device which can manipulate and obey symbols written on an infinite length of paper tape. The similarity to a CPU operating on a (sadly finite) length of address space is striking. At this stage, however, Turing was only using his design as a 'prop' to help answer a beautifully esoteric mathematical question. Opponents of 'blue sky research' on the basis that it doesn't help with practical problems should take note.

The war came, and Turing was seconded to Bletchley Park, Buckinghamshire, to join the Government team devoted to cracking the Germans' military cyphers, and in particular breaking an encoding device known as the 'Enigma machine'. Turing and his team acquitted themselves brilliantly, and by May 1941 was able to provide the Admiralty with decyphered traffic from the predatory U-Boats in the Atlantic, and thus protect Britain's vital line of supply to the US. Such was the importance of Bletchley Park that in October 1941, when Turing wrote a letter appealing for extra staff to Winston Churchill himself, he secured his needs at once on the Prime Minister's orders.

Towards the end of the war, Turing became somewhat remote from the day-to-day business of code cracking, and began to pursue thoughts of his own. The knowledge and experience of electronics he had gained decyphering codes were combined with his idea of an abstract 'Turing machine' - he invented the 'electronic brain'. When peace came, he joined the National Physical Laboratory, and wrote a report, 'Proposed Electronic Calculator', which described his machine - a general-purpose digital computer.

Given that the report was written before any computer existed, the depth of his vision is startling. Here is his description of the call/return/stack mechanism for subroutines: 'When we wish to start on a subsidiary operation we need only make note of where we left off the major operation and then apply the first instruction of the subsidiary. When the subsidiary is over we look up the note and continue with the major operation... [One way to do this is] to keep a list of these notes... with the most recent last.'

In some sense, after the completion of this report, nothing ever went quite right for Turing again. The NPL dragged its heels over the building of his machine, with the result that Manchester University was able to produce the first computer before the first valve had been plugged into his own machine. He moved to Manchester and contributed some early programs, but his heart wasn't in the work. His approach to programming was brutally primitive - he worked in machine code written as base 32 numbers written backwards, and never appeared interested in high-level computer languages.

In the end, Turing's homosexuality brought catastrophe. He foolishly reported a lover to the police for attempted theft. His secret was discovered, and he was charged and convicted of gross indecency. The barbaric punishment took the form of treatment with female hormones; in order to be effective in the 'reduction of libido', it was believed that the dosage had to be sufficient to cause the subject to grow breasts. Although he saw out this treatment, he seems to have failed to have re-established his life, and two years later he committed suicide.

Hodges brilliantly captures Turing's lonely figure; his descriptions of the technical issues are neither too light nor too complex; and, damn it, it's a dead good story. Definitely worth acquiring for the annual trip to Majorca.

Title: Alan Turing: The Enigma — *Pages: 586*
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Price: £8.99 — *ISBN: 0-09-911641-3*

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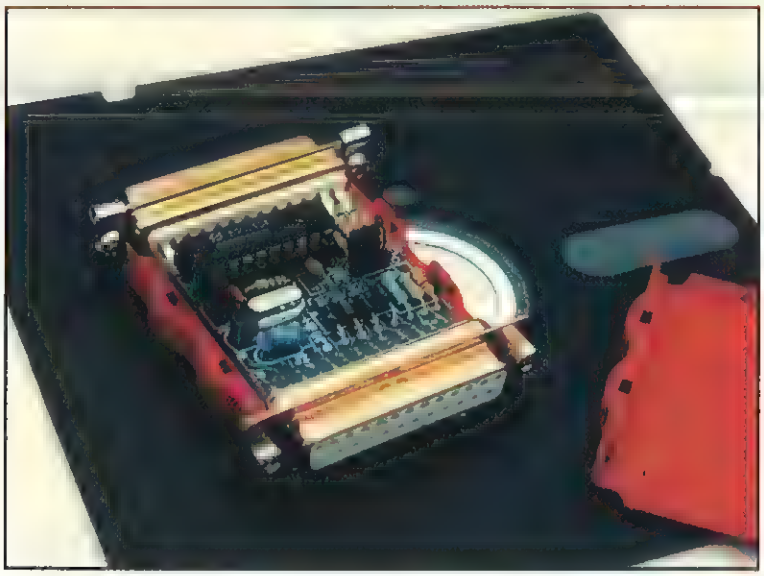

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We Have a Right to Know

Francis Glassborow discusses the practice of keeping compiler bug-lists secret.

I am not sure what you would like me to write about in future columns so please let me know if you would like something different. For now, I will assume that you have effective ways of dealing with your coding problems and so I will concentrate elsewhere.

One of CUG(UK)'s primary objectives is to campaign for better programming and better support for programmers. I will return to both these in future columns but this time I want to concentrate on the refusal by compiler writers to give us information we need. It is disgraceful.

Those who know me will be familiar with my claim that 'debuggers' are for finding bugs in the compiler. Those who know me well know that I mean it. In any other sphere of human endeavour a manufacturer who stayed silent about a potentially fatal flaw in a product would not remain in business - the damage suits would see to that. Not so in computing. Compiler manufacturers, almost without exception (Zortech was one of those rare ones), refuse to let us know of faults found in their products. The result can vary from hours of lost development time to serious damage to a developer's reputation.

As programmers, we know that programs have bugs just as 'typos' creep into the most carefully sub-edited text. We are skilled at finding ways to work around known bugs, sometimes too skilled for our own good and the work-around falls over when the compiler is fixed. We should not have to waste time with rediscovering bugs that are already known to a product's authors.

It has got to the state where many programmers no longer report bugs because they are fed up with the frequent reply 'Oh, we already know about that one.' That being the case, why didn't they tell us? Yes, I know the answer to that and it is just about as complimentary to your professionalism as consultants who suggest you are just games players (see letters in *.EXE* April '92).

The minimum registered users of a product should expect is regular information about bugs. Fixes would be nice but I will settle for being treated as an adult who can be trusted with the information that software is not perfect.

Programmers and software development managers should demand that the compiler producers acknowledge their 'Right to Know of Bugs.' That will make all our lives easier and reduce the log-jam on some technical support lines.

Now for something else. If you are coming to the 'C Plus C++ Conference' at Gatwick Hilton in June, please look me up as I shall be attending all week. The conference program looks excellent. I have enjoyed listening to many of the speakers in the past. The problem will be choosing between concurrent events.

The one event that you will have no problem with is an open meeting of CUG(UK) starting at 6 pm (just after the exhibition closes) on Thursday, 11th June.

.EXE

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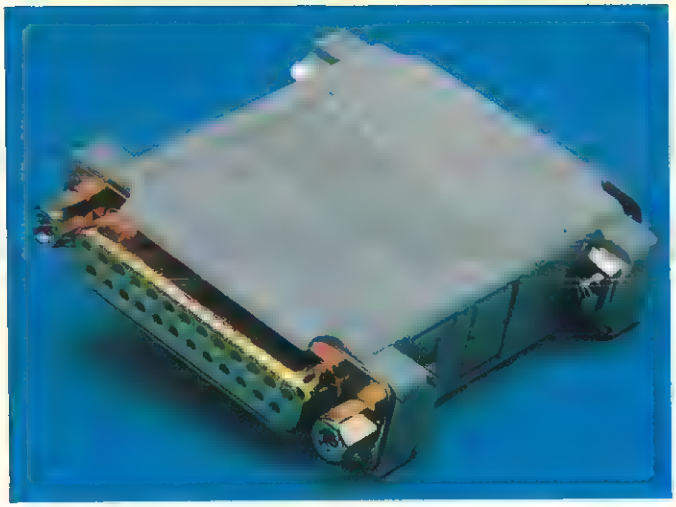

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CIRCLE NO. 961

Now we've got the language...

Some Problems for the C++ Community to Overcome If We Wish To See C++ Become a Widely Used Language.

So your software development team has learnt C++, understands classes and virtual functions, and has been converted to the benefits of object-oriented development. The time comes to start a large development project. So where do you go from here?

Accepted *industry* practice is to use project life-cycle methodologies to structure and control projects. Such projects pass through a number of stages on the route to completion: *high-level requirements definition and business cost justification, functional design, technical design, build and unit test* and *system test.*

Of course, the practitioners of such methodologies realise that blind adherence to a pre-defined sequence of stages does not guarantee a successful project - the talent of the development team is of course a vital factor. The use of methodologies does, however, provide an overall structure within which individual team members' creativity can be used to the full. It also provides the framework by which a project can be monitored against cost estimates - a vital factor for any commercial organisation. Finally, such methodologies provide useful analysis techniques such as *entity relationship diagrams, data flow diagrams or functional hierarchies.*

Herein lies the problem:

- Is the traditional waterfall cascade approach (outlined above) still valid in an object oriented environment? There is much current discussion about prototyping approaches, but how does one monitor (in a financial sense) such a prototyping approach?
- At which point in the life cycle does it become important to have an understanding of C++? Knowledge of C++ is obviously a prerequisite during technical design, but is it necessary during functional design?
- Exactly what is the relationship between established analysis techniques such as entity relationship diagrams/function hierarchies and class design? Intuitively there must be a relationship. Entity relationship diagrams contain information about the data (attributes) that is stored in business entities, and the (business) relationships between entities. Function hierarchies, which are generally cross referenced against entities, contain information about the functionality of the required system. Classes are an encapsulation of both data and functionality. There are clearly similarities between both approaches, especially when one considers the use of entity *hierarchies* (similar to class hierarchies?) in certain analysis techniques.
- What migration steps should be used to convert any existing analysis staff to an object-oriented approach? Indeed, is the analysis/programming split valid given this approach?
- What constitutes a *good* class design? What objective criteria can be applied to an object oriented design to ensure its integrity and completeness? Does the design have the capability to incorporate future enhancements cost-effectively - one of the main reasons for moving to an object-oriented approach in the first place?

These are some of the problems to which the C++ community must provide answers if we wish (and why shouldn't we) to see C++ become an established industry language. Answers on a postcard....

EXE

Subscription to the ECUG is £50 per annum. For more information about its activities, contact Rebecca Thomas on 071 253 5121, or write to ECUG, c/o City House, 190 City Road, London EC1V 2QH.

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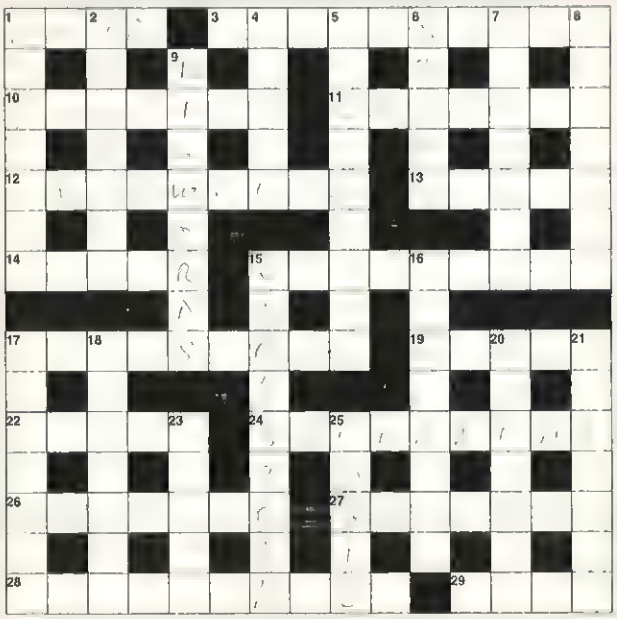

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3 Use it to study the working range of a PC (10)
10 Not dreamily dealing with integers? (7)
11 Main raw material carrier (3,4)
12 Cover up when not in insert mode (9)
13 Lots of shots - five and none - follow little girl (5)
14 He makes life simple in recent festival without the start (5)
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19 Old sodium salt may get up my nose (5)
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8 Blow up like our field in the 80s (7)
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21 Fictional feet marking the keys maybe (7)
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25 Bit of wood on a chip may be the basis for non-fuzzy computing (5)

'.EXEWORD' compiled by Eric Deeson

C	O	N	N	E	X	I	O	N	■	S	C	R	A	P
R	■	E	■	X	■	B	■	O	■	O	■	O	■	A
A	N	T	I	C	■	M	O	D	U	L	A	T	O	R
S	■	W	■	E	■	S	■	U	■	U	■	O	■	T
H	O	O	T	E	R	S	■	L	I	B	E	R	T	Y
■	■	R	■	D	■	T	■	E	■	L	■	■	■	L
P	A	K	I	S	T	A	N	■	G	E	M	I	N	I
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O	R	D	E	R	S	■	S	O	F	T	W	A	R	E
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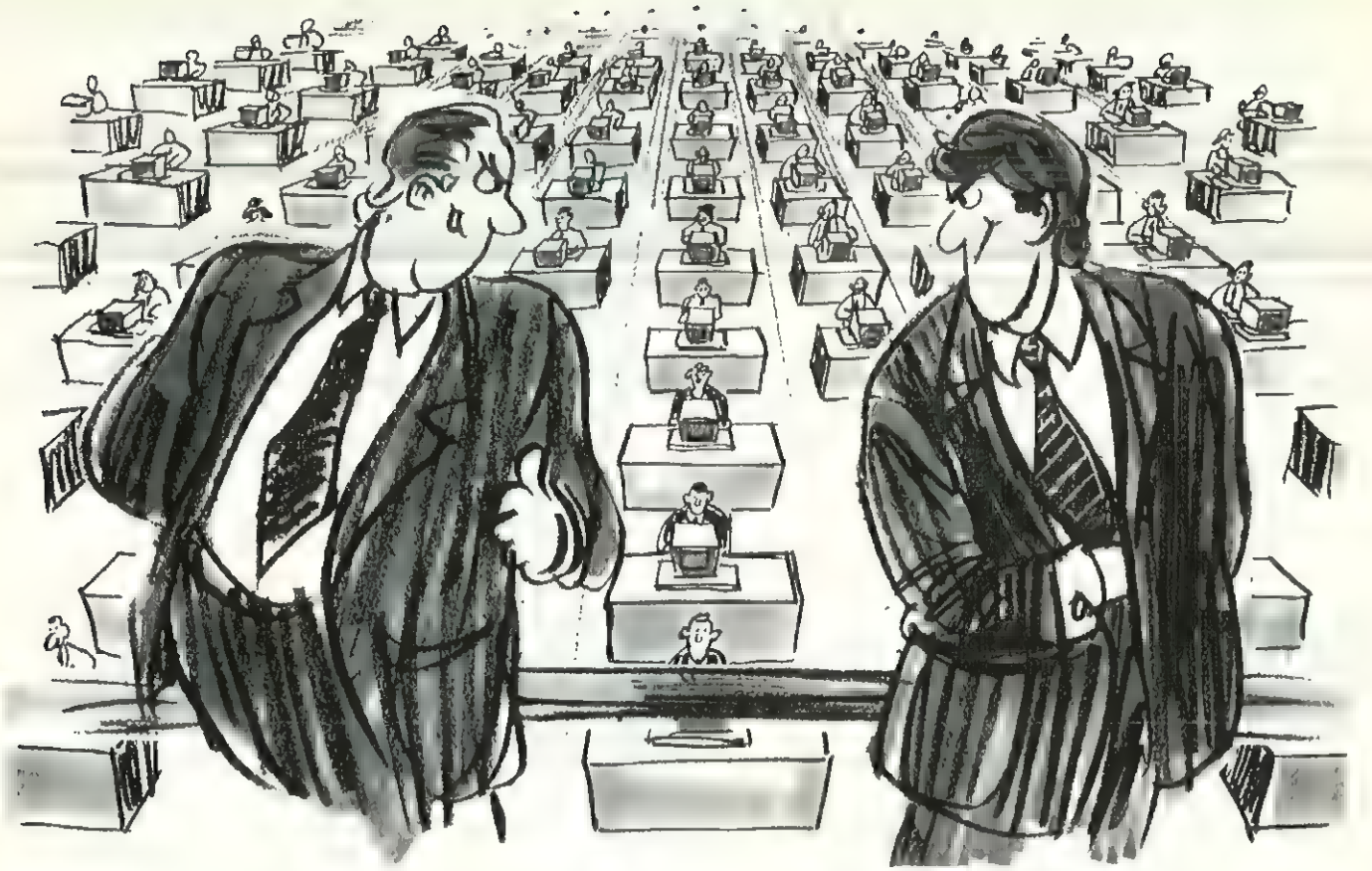

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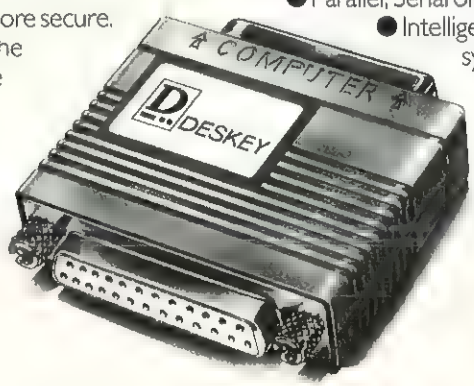

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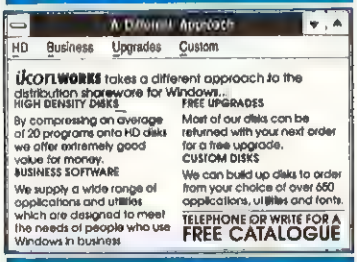

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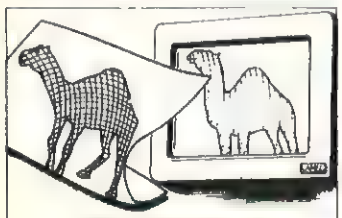

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ACTIS is seeking people with good technical experience of **OPEN SYSTEMS** which is still a growing sector of the IT market.

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Relational Database/SQL
4 GLs, CASE, IPSE
C and WINDOWS
Accounts/Commercial and Scientific Programming
Training and Documentation
Technical Sales

We are seeking consultant, project management, development and support staff from graduate trainees to those with ten years experience.

To discuss these and other opportunities talk to **Honor Lindsey** on **(0204) 20200** or send your CV to **ACTIS RECRUITMENT 17 CHORLEY NEW RD, BOLTON BL1 4QR**

ACTIS

PEOPLE IN UNIX*

Are YOU looking for PC Systems Analysts, C Programmers, PC Support Analysts, Unix Gurus, S/W Development Engineers, Network Specialists, Object Oriented Systems Designers, Real Time Engineers, Database Developers, Application Support Engineers,Windows Programmers, CAD CAM Experts, Graphics Specialists.....and more?

LOOK NO FURTHER THAN THESE PAGES.

Call us on **081-994-6477** to find out more about this unique advertising medium.

Of course they all come with their experience in ADA, PASCAL, ORACLE, C, C++, WINDOWS, CLIPPER, MOTIF, SQL, CAD-CAM, ASSEMBLER, LANs, WANs, dBase UNIX.....

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the soft (corporation)

Specialists in relational databases, open systems and structured techniques.

ORACLE/SQL/ EMBEDDED SQL

Candidates with skills in SQL and embedded SQL are immediately required by clients involved in applications as varied as financial information systems to pan European manufacturing/ distribution and leasing systems. Strong SQL experience coupled with low-level language interfaces to 3GL's and screen painting methods are important. Training in the latest Oracle tools and methods given where necessary. The new and existing implementations are running under VMS, ULTRIX, UNIX and sunOS with some links to multi-user PC systems. Other database knowledge may also be of interest.

£12,000-35,000+
Ref SC/1/.exe

INGRES

Excellent opportunities exist for any INGRES development staff from Programmers up to Project Manager level. Candidates will be using the most advanced development tools available with companies investing in leading edge technology. INGRES/STAR, GUI's, SQL and OPEN SQL, decision support/application development tools, user interfaces and structured methods (SSADM, YOURDON, JACKSON), C, COBOL, are the priorities. Potential to work across varied hardware platforms is also a preference. Opportunities exist in Banks, Building Societies, Software and Systems Houses and Governmental Bodies.

£12,000-35,000+
Ref SC/2/.exe

SOFTWARE DEVELOPERS DATABASE DESIGN

SYBASE, INGRES, INFORMIX,ORACLE, UNIFY,CLIPPER, PRO IV, POWERHOUSE, RDB, ALL, SEACHANGE, PROGRESS, SB+, INFORMATION-and interfaces to 3GL's - C, C++, PASCAL and FORTRAN and even COBOL and BASIC! Our client companies require candidates with the following skills: Technical Software Development, Software Engineering, Pre/Post Sales, Database Design and Systems Consultancy. Areas of particular interest include: Distributed Systems, Object Oriented Databases, LANS, WANS, Graphics Image Processing, Windows, Formal Design Methodologies, CASE Tools, Expert Systems, Knowledge Engineering, Office Automation, Compilers, Low Level Design, Data Integration and varied application design. COMPUTER POLYGLOTS need apply!

£12,000-40,000
Ref SC/6/.exe

C/UNIX/MS-DOS

Software Houses and End Users in Manufacturing, Commercial, Scientific and Government application environments alike require excellent C skills. Low-level machine knowledge, operating systems internals, and use of debuggers/compilers are required. Software development experience is the key, and being able to deliver high performance, high quality, well specified software in competitive time scales. Opportunities vary from small software companies involved in expert systems, GUI's, Images Processing, GIS,EIS, Communications, Networking and Object Oriented Databases to large scale communication companies systems. Graduates through to senior software engineers/team leaders are required. UNIX internals and Kernel level knowledge are also very much in demand.

£14,000-35,000
Ref SC/3/.exe

COMMUNICATIONS/ NETWORKING

Developments as varied as Voice-activated relational database recognition systems, Protocol enhancement at transport, session and presentation level and World-wide communications systems utilising LAN's and WAN's across different hardware platforms are currently available. Experience of ETHERNET, TCP/IP, NFS, X25, X400, X500 in a UNIX, VMS, sunOS and also fault tolerant environments are required. Some exposure to structured methods and other leading edge technology would be a bonus, though training will be given. Knowledge of industry standards and committees is also relevant at more senior levels. UNIX Kernel knowledge is at a premium.

£12,000-£35,000
Ref SC/4/.exe

X WINDOWS/ MS-WINDOWS/MOTIF

Graduates (1 year+) to Senior Software Engineers with an interest in advanced development environments need apply for varied positions with companies dedicated to leading edge technology. A mixture of the following skills in a development environment are preferred: GUI's, Document Image Processing, OCR technology, Client/Server applications and WYSIWYG techniques coupled with experience of UNIX, sunOS, MS-DOS, or ULTRIX/VMS and Interfaces to relational (primarily INGRES or SYBASE) and Networking (TCP/IP, NFS, X400) technology. Application areas vary from Retail, distribution to finance and Software Vendors to End User environments.

£12,000-35,000 + BENEFITS
Ref SC/5/.exe

SOFTWARE ENGINEERS

Clients-End-Users, Software Vendors and Software Houses dedicated to strategic implementation of leading edge technology and integration of applications across different hardware and operating systems platforms require candidates to degree level with a scientific/technical development bias and a 1-3 years' experience. There are two main options:-

TECHNICAL DEVELOPMENT: Continued use of UNIX, VMS, MS-DOS, C, Windows, Pascal, C++, Ada, Prolog, OOPS, Networking and Communications with companies offering technology based careers and management responsibility.

COMMERCIAL DEVELOPMENT: Using technical skills already developed, but offering opportunities to apply analysis and design skills rather than remain a 'technical guru'. Please call to discuss your particular career path, growth and potential.

£12,000-25,000 + BENEFITS
Ref SC/7/.exe

SYBASE/UNIFACE

Due to the continued expansion of the market for RDBMS as a multi purpose software development tool and particularly the adaptability of SYBASE, its popularity is growing in manufacturing, scientific, industrial, commercial and financial application areas. Clients throughout the UK and Europe require SYBASE experience in a VMS, UNIX and even PC environment. Again interfaces to 3GLs, Structured Methods and Communications Protocols are also important. Please call to discuss the varied opportunities at all levels, including setting up new development departments.

£12,000-40,000 + BENEFITS
Ref SC/8/.exe

INFORMIX/CLIPPER

Clients involved in small to medium database projects (10 to 35 users) utilising products like INFORMIX, CLIPPER, DBASE IV and FOXBASE require Programmers Analyst/ Programmers with 4GLs, C, Pascal, Turbo Pascal, Quickbasic etc... or some of these skills for new and existing developments. Potential to get involved in Networking projects and in some cases larger scale projects involving cross-training also exist.

£12,000-22,000
Ref SC/9/.exe

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ADVERTISERS INDEX

STOB - Testing away

Verity Stob has been benchtesting 25 PC Magazines in the .EXE labs.

British PC Person. 324 pages. Main features: comparison of 23 VGA colour monitors, review of the new WordStarPerfect for Windows word processor ('we liked the way that WordStarPerfect takes advantage of the Windows environment, without betraying its DOS origins... With its speedy response and its QuickTypoBar feature, how can this package fail?'), an overlong April Fool joke item purporting to compare the comparative features of 35 mouse mats, and a rich selection of regular columnists and smaller reviews. We particularly admired Danny Rat's technical column: Why I don't have to write anything this month because fortunately you've sent in enough stuff.

Noise made when dropped on carpeted floor from a height of six feet: *ffflonk!*

American Corporate Computer Type, UK Edition. 478 pages. A newcomer to the news-stands, this issue of ACCT UK came with a free 3.5" disk of 'white-hot DOS utilities', including a menu-driven replacement for the DIR command (unfortunately in French, 'Les fiches sont...'), a dBASE II compatible card index system and a crash-prone demo version of a game called 'Gerbils'. The magazine was divided between 390 pages of advertisements, many of them different, and 88 pages of editorial. The main feature was a comparative review of 55 different brands of PC keyboard ('if it is to make any impact in the PC keyboard market, Keitso really must do something about the positioning of the Caps Lock LED on its 112-key range'). Support features included a review of the new WordStarPerfect for Windows word processor ('now that Windows is established as the corporate operating system of choice, WordStarPerfect really needs to make up its mind whether it is going to support the new environment or drift into retirement under DOS... this bodge of a word processor is neither one thing or the other, notwithstanding the inclusion of stupid gimmicks like the QuickTypoBar') and a column by Bill Hack, the Fearless Voice of Corporate Computing ('now that OS/2 2.0 has arrived, questions must hang over Windows's status as the corporate operating system of choice').

Noise made when dropped from a height of six feet: *ker-splatt!*

PC-Fuss. 320 pages. PC-Fuss also comes with a disk of 'Brill Utils and K-k-krazy games' sticky-taped to its cover; programs included were 'Disk Surgeon', a FAT table repair facility that copes quite well with pre DOS 4 floppy disks, 'MyMate', a memory-resident ASCII editor which requires 100 KB of conventional RAM to run, and 'Piggy the Porcupine', the demo version of an action arcade game from the people who brought you Wally the Wombat, Ernest the Earwig, Toppy the Tapeworm etc. PC-Fuss's main feature is a comparative review of 104 text-mode based word processors ('because whatever you say about Windows, it's clear that good ol' DOS is going to be with us for some time to come'). Also reviewed is the WordStarPerfect for Windows word processor ('now that everybody uses Windows all the time, it's good to see that WordStarPerfect has finally made the leap into the 19th Century and left slimy old DOS behind it').

Noise made when dropped: *whooomphh.*

The Editor has spiked Ms Stob's copy covering the remaining 22 magazines, on the grounds that only bananas would wish to read a review of so many drearily similar products. We believe that the market for such bananas is already amply catered for.

EXE

1 Golden Square, London W1R 3AB
Tel: 071-734 8434 Fax: 071-734 8379

Senior Software Engineer
Midlands **£18K**

You will be expected to produce software packages usually in Assembly level language for incorporation into this company's product range. You will be working by yourself or on small team projects. The kind of skills that are required are: good Assembler (z80 and linker), MASM 8086 Assembler and linker, MS DOS and one high level language preferably C, Basic or Pascal. You must have at least three years experience and have a flexible approach to work.

OSF Motif X-Windows UNIX Developers
Cambs **£23K**

This renowned Company that is heavily involved with UNIX Windows and utility development is desperate for some extremely skilled individuals. You should have a good development background and be used to dealing with clients/end-users specific tailoring requirements. There should be some international travel involved, (User Group and Conferences etc) and you should feel self sufficient in your own ability. Being a graduate is not necessarily a prerequisite, just being an able developer is...

SQL RBT or Windows SQL Specialist
Berks **Car & up to £30K**

This Company is a renowned international software house that requires two such individuals. You must have a proven development record within at least one major project. In return, you will have a vigorous and varied role, throughout Europe and GB; consulting, tailoring and supporting the company's products and developments; would suit a coder who wants to have a more consultative role. You should be a graduate, or high flying individual with A Levels at the least.

UNIX Motif Realtime Dealing Systems C
London **Benefits and up to £25K**

This solutions house have a tremendous reputation in the stock market/'broking trade. the product is proven and a success - the company is looking to employ a new project team and requires a calibre developer, preferably with a minimum of two years experience and probably a Computer Science graduate.

Windows Datacomms Novell Connectivity
Middx **Car up to £27K**

This company has been a proven success story since setting up their European office here two years ago. They are involved in AS400 and mainframe client/server style connectivity, for PC Windows applications. You should have worked in Comms/Network environment and feel confident in your 3270 skills.

4GL PROIV Complex RDBMS Multiuser
London **Up to £20K**

Pick, mainframe, UNIX platforms or any other multi-user experience would be extremely important to the company. A broad sweep of skills for this information/image processing/satellite company is a prerequisite. Structured methodologies are a must and a willingness to learn new skills is essential.

Group MIS Manager UNIX Kilostream
Sheffield + Europe **Benefits, £Good**

Good European languages; French or Spanish, ten years experience and networks TCP/IP or 3COM products could be useful. It could be envisaged that some European travel will be a regular element to the job. Typical backgrounds would include development and some technical support, also some HP3000 platform work could be useful, but not essential.

Realtime Comms Development Assembler C
Kent **Up to £22K**

6800, 6809, OS9 and comms protocol experience; SDLC & PLC. Other work will include development on Xenix emulators, comms analysers and the like. This development would appeal to a Senior Software Engineer who wishes to combine classic comms work with C coding and Realtime applications. the company is involved with process control software and is extremely successful in the arena.

C Windows PC Smalltalk C++
W.London **£Good**

Development department of a large Japanese hardware company is getting heavily involved in a GUI bundling exercise. They want an individual who has a solid computer science/software engineering graduate background - second jobber, minimum experience is 2 years in development.

Mainframe Products in a PC Environment
Berks/Hants **£Good, Car, Benefits**

Product support role for PC company emulating MVS development; utilities, operating systems, tools, development languages and 4GLs. You should have had good experience in all of these and be able to "translate" their applications to a PC Lan development environment. A challenging role for the right individual, it is envisaged that the minimum age requirement would be at least 28, you should have good mainframe system level skills.

Sybase Oracle Ingres Informix PC or UNIX
Home Counties **Up to 35K + Benefits**

A major player in the banking and finance software sector is looking for high calibre developers. You must be used to a high degree of flexibility and have a structured development background - Yourdon, Jackson etc. The rewards will be evident and a good career path with European travel are a certainty.

IF ANY OF THESE POSITIONS ARE AT ALL SUITABLE, OR EVEN IF YOUR SKILLS ARE NOT QUITE WHAT IS REQUIRED, DO NOT HESITATE TO GIVE MIKE DEARING A CALL ON 071-734 8434 OR AFTER HOURS ON 081-767 1003. LOOK FOR REGULAR UPDATES ON ORACLE TELETEXT.

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